FOURTEENTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE

1898.

PART II OF THE ANNUAL REPORT OF THE UNIVERSITY OF MAINE.

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The Bulletins of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,

Orono, Maine.

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A. W. Harris, Sc. D., President of the University of Maine:

SIR:—I transmit herewith the Fourteenth Annual Report of the Maine Agricultural Experiment Station for the year ending December 31, 1898.

CHARLES D. WOODS,
Director.

ORONO, Maine, December 31, 1898.

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

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Lucius J. Shepard	*Assistant Horticulturist*
Ora W. Knight	*Assistant Chemist*
Andrew J. Patten	*Assistant Chemist*
Horace L. White	*Assistant Chemist*

ANNOUNCEMENTS.

ESTABLISHMENT OF THE STATION.

The Maine Agricultural Experiment Station was established in accordance with Chapter 294 of the Public Laws of 1885 "for the purpose of protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds, and for the purpose of promoting agriculture by scientific investigation and experiment."

In March, 1887, Congress passed an act establishing experiment stations in the several states. The Maine Legislature of 1887 accepted this grant and made the Maine Agricultural Experiment Station as it now is.

THE OBJECT OF THE STATION.

The purpose of the experiment stations is defined in the act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and

cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

INSPECTIONS.

In accepting the provisions of the Act of Congress, the Maine Legislature withdrew the State appropriation for the maintenance of the Station, and thereby did away with the original purpose of the Station so far as it related to the "protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds." In place of this, special laws regulating the sale of commercial fertilizers, concentrated commercial feeding stuffs and agricultural seeds, and the inspection of chemical glass-ware used by creameries, have been enacted, and their execution entrusted to the Director of the Station.

The Station officers take pains to obtain for analysis samples of all commercial fertilizers and concentrated commercial feeding stuffs coming under the law, but the organized co-operation of farmers is essential for the full and timely protection of their interests. Granges and other organizations can render efficient aid by sending, early in the season, samples taken from stock in the market and drawn in accordance with the Station directions for sampling.

THE AIM OF THE STATION.

Every citizen of Maine, concerned in agriculture, farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glass-ware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published if they prove of general interest.

STATION PUBLICATIONS.

The Station publishes annually a report covering in detail its expenses, operations, investigations and results, and bulletins giving popular accounts of the results of Station work which relate directly to farm practice. The bulletins are mailed free to all citizens who request them. The annual report is bound with that of the Board of Agriculture and distributed by the Secretary of the Board. This combined report can be obtained by addressing the Secretary of Agriculture, State House, Augusta, Maine. It is usually ready for distribution in August of each year.

CORRESPONDENCE.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications should, therefore, be addressed to the

Agricultural Experiment Station,
Orono, Maine.

The post office, railroad station, freight, express and telegraph address is Orono, Maine. Visitors to the Station can take the electric cars at Bangor and Old Town.

The telephone call is "Bangor, 27-3."

Directions, forms and labels for taking samples, and charges for examining fertilizers, feeding stuffs and seeds for private parties can be had on application.

Parcels sent by express should be prepaid, and postage should be enclosed in private letters demanding a reply.

Remittances should be made payable to the undersigned.

CHAS. D. WOODS, *Director.*

ACKOWLEDGMENTS.

Acknowledgment is hereby made for the following gifts to the Station during 1898:

Corn Germs—Glucose Sugar Refining Co., Chicago, Ill.

Gluten Feed—Glucose Sugar Refining Co., Chicago, Ill.

Seeds of Vetch, Peas, and Sunflower; Cherry Pits; Scions, Plants and Apple Trees; Currant and Raspberry Cuttings,—Cook's Inlet, Alaska; Cranberry Plants from Sitka, Alaska—United States Dept. of Agriculture.

"Sample" Strawberry Plants—C. S. Pratt, Reading, Mass.

Apple Scions—Jules Lagacé, Upper Frenchville, Me.

Scythes—Nolin Manufacturing Co.

Green Arsenite—Adler Color & Chemical Works, New York City.

Laurel Green—Nichols Chemical Company, Syracuse, N. Y.

Skabcura—Skabcura Dip Co., St. Louis, Mo.

Nikoteen—Skabcura Dip Co., St. Louis, Mo.

Silicate and Muriate of Potash—German Kali Works, New York City.

"Diamond Crystal" Salt—Genesee Salt Company.

Champion Milk Cooler and Aerator.

Facile Babcock Apparatus.

Excelsior Incubator.—J. H. Stahl, Quincy, Ill.

The following newspapers and other publications are kindly donated to the Station by the publishers:

Agricultural Epitomist, Indianapolis, Ind.

Agricultural Gazette, Sidney, New South Wales.

American Cultivator, Boston, Mass.

American Dairyman, New York City.

American Fertilizer, Philadelphia, Pa.

American Florist, Chicago, Ill.

American Grange Bulletin, Cincinnati, Ohio.

American Grocer, New York City.

American Miller, Chicago, Ill.

Baltimore Weekly Sun, Baltimore, Md.

Bangor Weekly Commercial, Bangor, Me.
Campbell's Soil Culture, Omaha, Neb.
Canadian Horticulturist, Grimsby, Ont.
Chronique Agricole, Lausanne, Switzerland.
Cultivator and Country Gentleman, Albany, N. Y.
Dairy World, Chicago, Ill.
Detroit Free Press, Detroit, Mich.
Elgin Dairy Report, Elgin, Ill.
Farm, Furnace and Factory, Roanoke, Va.
Farm Reporter, Charleston, W. Va.
Farmer's Advocate, Burlington, Vt.
Farmer's Advocate, London, Ont.
Farmer's Guide, Huntington, Ind.
Farmer's Home, Dayton, Ohio.
Farm Home, Springfield, Ill.
Farmers' Tribune, Des Moines, Iowa.
Farm and Home, Chicago, Ill.
Farm Journal, Philadelphia, Pa.
Farmer's Magazine, Springfield, Ill.
Farmer's Review, Chicago, Ill.
Farmer's Voice, Chicago, Ill.
Farming, Dayton, Ohio.
Florists Exchange, New York, N. Y.
Forester, Princeton, N. J.
Fruit, Dunkirk, N. Y.
Gentleman Farmer, Chicago, Ill.
Green's Fruit Grower, Rochester, N. Y.
Hoard's Dairyman, Ft. Atkinson, Wis.
Holstein Friesian Register, Brattleboro, Vt.
Homestead, Des Moines, Iowa.
Horticultural Visitor, Kinmundy, Ill.
Independent Democrat, Morgan City, La.
Jersey Bulletin, Indianapolis, Ind.
Journal of the Royal Agricultural Society, London, England.
Journal of the Irish Dairy Association, Limerick, Ireland.
Louisiana Planter, New Orleans, La.
Lewiston Weekly Journal, Lewiston, Me.
Maine Farmer, Augusta, Me.
Mark Lane's Express, London, England.
Market Basket, Philadelphia, Pa.

Market Garden, Minneapolis, Minn.
Massachusetts Ploughman, Boston, Mass.
Michigan Farmer, Detroit, Mich.
Michigan Fruit Grower, Grand Rapids, Mich.
Mirror and Farmer, Manchester, N. H.
Montana Fruit Grower, Missoula, Mont.
National Farmer and Stock Grower, National Stock Yards, Ill.
National Stockman and Farmer, Boston, Mass.
New England Farmer, Boston, Mass.
New England Florist, Boston, Mass.
New England Homestead, Springfield, Mass.
New York Farmer, Port Jervis, N. Y.
New York Produce Review, New York City.
North American Horticulturist, Monroe, Mich.
Northern Leader, Fort Fairfield, Me.
Northwestern Miller, Minneapolis, Minn.
Ohio Farmer, Cleveland, Ohio.
Oregon Agriculturist, Portland, Oregon.
Pacific Coast Dairyman, Tacoma, Wash.
Park and Cemetery, Chicago, Ill.
Practical Farmer, Philadelphia, Pa.
Public Ledger, Philadelphia, Pa.
Ruralist, Gluckheim, Md.
Rural Californian, Los Angeles, Cal.
Rural Canadian, Toronto, Ont.
Rural Helper, York, Nebraska.
Rural New-Yorker, New York City.
Southern Farm Magazine, Baltimore, Md.
Southern Farmer, New Orleans, La.
Southern Planter, Richmond, Va.
Southern States, Baltimore, Md.
Southwestern Farmer, Wichita, Kans.
Strawberry Specialist, Kittrell, N. C.
Sugar Beet, Philadelphia, Pa.
Turf, Farm and Home, Waterville, Me.
Vick's Magazine, Rochester, N. Y.
Wallace's Farmer, Des Moines, Iowa.
Western Agriculturist, Chicago, Ill.
Western Creamery, San Francisco, Cal.
Western Fruit Grower, St. Joseph, Mo.
The World, Vancouver, B. C.

[Reprints of Bulletins issued in 1898.]

Bulletin No. 41.

DEHORNING COWS.

G. M. Gowell and F. L. Russell.

In this country dehorning of cattle has been practiced to a considerable extent for about ten years and in England for a longer time. At first the methods used were very crude. The animal had to be closely confined and the horns were removed with a saw, which required considerable time and must have been very painful to the animal. Occasionally even now horns are removed with a saw but the common practice is to use specially constructed clippers, which do the work better in every way. Almost no apparatus is required to confine the animals and one stroke of the clippers removes a horn, frequently in a single second of time and with comparatively little pain. The operation has become so simple, that, in view of the very manifest advantages resulting from it, it is not strange that it is coming to be very generally adopted. Horns are no longer needed by cattle as weapons of defence against natural enemies and serve no good purpose.

EXPERT OPINION OF DEHORNING.

Dehorning is practiced at several experiment stations in this country and the published results indicate that the pain suffered by the animals is not to be compared with injuries which cattle inflict on each other with their horns. The Texas Station finds "that a drove of the wildest dehorned cattle may run loose together in a building like a flock of sheep, and they will fatten faster after dehorning than before."

In Bulletin 54 of the Cornell Station, Professor Roberts gives quite a full account of the history of dehorning. He says it has been found to be of great practical utility in rendering animals more docile and quiet, in rendering them much less capable of injuring each other or mankind, and in reducing the space necessary for safe housing and shipping.

The following is quoted from the above named bulletin: "In Canada the Ontario government appointed a commission 'To obtain the fullest information in reference to the practice recently introduced into this province of dehorning cattle, and to make full inquiry into and report the reasons for and against the practice.'

"Evidence was received from the representatives of all the interests affected by the practice, including farmers, dairymen, drovers, exporters, wholesale and retail butchers, cattle market attendants, tanners, hide merchants, veterinary surgeons, medical practitioners and members of humane societies,—ninety-eight in all.

"Of the farmers examined, nearly seventy in number, all who had either performed or seen the operation performed, with three or four exceptions, were strongely in favor of it, the majority stating that they were prejudiced against it on the grounds of cruelty until they gained a practical knowledge of it. Of the farmers opposed to the practice, not more than three or four had ever seen the operation, but they thought it cruel and unnecessary.

"Evidence as to the loss caused by animals using their horns upon each other was given by cattle buyers and others in frequent attendance at the cattle market, and also by butchers and tanners.

"Among veterinary surgeons a considerable conflict of opinion was found to exist. As in the case of the farmers, those who had seen the operation and observed its effects were in favor of it, while those who had not seen it were opposed to it.

"Indeed, as regards all the evidence received by the commission, it might almost be given as the rule that where the operation was properly and skillfully performed, those witnessing it, however prejudiced before, became converts to it, while the great bulk of the opposition came from parties not acquainted with

the operation, and who entertained exaggerated ideas as to its severity.

"In no case were witnesses able to refer to an instance where a farmer was dissatisfied with the results or willing to give up his right to continue the practice, after having performed the operation.

"In addition to the evidence as to the amount of pain involved in the operation, much evidence was received as to the commercial advantages accruing from the operation, and emphasizing the point that a great deal of suffering is prevented by the removal of the horns."

As a result of the inquiry the commission unanimously recommended that the practice of dehorning be permitted and encouraged.

DEHORNING AT THE MAINE STATION.

Part of the Station herd were hornless; the remainder were dehorned to secure a greater degree of quiet among the animals when all alike were dehorned, and to lessen the danger of injury to each other and the attendants.

While the Station has never lost an animal from goring, we have at several different times had animals severely injured, and not a season passes but some of the herd are marked by the sharp horns of their companions. In winter, when the animals are turned into the yards for exercise, their exuberance of spirits and love of frolic sometimes carry them so far as to cause them to chastise each other severely. The most serious trouble occurs during fly time when animals, desperate from the annoyance of the winged pests, rush among their mates, hooking right and left, and showing no mercy in their momentary frenzy.

For the last three years the calves born in the Station herd have been dehorned when young by the use of caustic potash. The dehorning has been done as soon as the buttons could be felt, and not later than twenty days from birth. Calves dehorned at this age have never yet shown any horns. One, dehorned when thirty-five days old, developed dwarfed horns an inch or an inch and a half long.

Dehorning with potash is done by clipping the hair away from around the buttons, moistening the end of the potash slightly,

and rubbing one embryo horn for four or five seconds, then moistening the potash again and rubbing the other horn in the same manner. Each horn should be thus treated four or five times. Four or five minutes' time is required in dehorning a calf. Care should be taken not to have too much moisture about the potash as it might spread and remove the hair from too large a surface. The calf should be kept from getting wet during the next few days for the same reason. Healing soon follows the operation and smooth polls have resulted in every case except the one mentioned as having been done at too late an age.

The eleventh of last June, all of the cows in the herd with horns were dehorned. All the wounds bled at the time of the operation. Two bled considerably for about an hour and slightly for another hour, but no animal gave evidence of suffering from loss of blood. The operation was evidently painful to the animals. The period of pain appeared to be limited to the time when the clipper was in process of closing, which was at most but a few seconds in each case. After being released the animals went about the paddock as usual, and an hour or two later, when they were put into the barn, they ate their dinner as though nothing unusual had taken place.

The milk yield showed no appreciable decrease, even on the days immediately following the operation. As it was not intended, at the time, to prepare a bulletin upon the subject, the daily milk records were destroyed after being credited upon the monthly account, consequently they cannot be presented here.

On page 17 are presented the monthly milk and fat yields of all the cows from May to August, inclusive, that the reader may have the data relative to the thrift and condition of the animals since the operation. As will be seen in the table, most of the animals were well advanced in the period of lactation. The shrinkage in milk flow and butter yield is for the most part less than would be usually expected from advancement in period of lactation. The dehorning apparently had no effect upon either milk flow or yield of butter fat.

Our experience is in accord with that elsewhere. The Minnesota Station compared the yield of milk and butter fat of nine cows for three milkings before dehorning with the yield of the same cows for three milkings after dehorning. A very

slight decrease was noticed. That even this small decrease was due to other causes than dehorning is indicated from the fact that the relative decrease in the milk and fat yield was greater in the case of six cows that were not dehorned.

Yields of milk and butter fat for two months before and two months after dehorning, and for the month of June in which the cows were dehorned.

	Breed.	Age—years.	Months since last calf.	Months till due to calve.	April—lbs.	May—lbs.	June—lbs.	July—lbs.	August—lbs.
LOBLITOP	Jersey	9	9	4					
Milk yield					637	672	713	643	559
Butter fat					27.4	28.2	34.2	30.9	26.3
ROSE	Jersey	10	9	5					
Milk yield					584	598	587	567	555
Butter fat					28.7	23.9	28.7	26.7	26.7
ADDIE S	Jersey	8	9	4					
Milk yield					464	452	465	262	163
Butter fat					23.2	18.1	23.3	12.3	3.1
HOPE	Jersey	6	8	4					
Milk yield					399	400	343	334	293
Butter fat					21.6	20.8	18.8	18.4	16.8
TULIP	Jersey	6	5	7					
Milk yield					826	789	759	693	640
Butter fat					45.5	39.4	42.5	34.6	32.0
RUTH	Jersey	5	8	6					
Milk yield					567	577	582	534	472
Butter fat					26.1	28.3	30.8	33.7	26.4
PANSY	Jersey	7	3	10					
Milk yield					268	719	673	644	645
Butter fat					9.4	25.2	33.6	30.9	33.5
ORLETTA	Jersey	10	8	5					
Milk yield					522	560	552	502	420
Butter fat					25.6	25.8	26.5	26.1	23.5
LOBTY	Jersey	4	13	5					
Milk yield					236	237	236	198	120
Butter fat					10.4	13.2	13.0	11.5	7.1
DUDLEY	Jersey	7	19	*					
Milk yield					487	485	355	19	720
Butter fat					24.9	24.3	19.2	.7	28.8
TURNER	Jersey	8	7	5					
Milk yield					531	563	543	453	401
Butter fat					22.3	23.7	23.9	21.7	18.5
ADLE	Jersey	5	2	10					
Milk yield					56	653	709	676	682
Butter fat					4.2	33.3	41.1	36.5	38.2
LOTTIE	Jersey	10	8	†					
Milk yield					548	546	554	516	579
Butter fat					31.7	30.6	32.1	28.9	31.9
MADALINE	Jersey	9	3	10					
Milk yield					1,108	975	879	840	825
Butter fat					46.6	41.0	35.0	33.6	31.3
HUNTON	Holstein	9	4	†					
Milk yield					513	972	880	846	798
Butter fat					18.0	33.0	35.2	33.9	33.5
FATAMIE	Holstein	9	3	†					
Milk yield					1,095	926	765	812	852
Butter fat					38.3	31.4	26.0	29.2	30.7
DUPLICATE	Jersey	2	3	†					
Milk yield					513	486	455	432	378
Butter fat					23.6	25.3	21.8	20.3	18.5

*Calved July 27, 1897. †Not with calf.

In Bulletin No. 37 of the Cornell Experiment Station the statement is made that with an experience of six or seven years in dehorning, although the operation has usually been performed by inexperienced persons, no ill effects have followed. A comparison of the milk yield of five dehorned cows and seven cows not dehorned indicates that the dehorning did not reduce the yield.

CONCLUSIONS IN REGARD TO DEHORNING CATTLE.

1. Dehorning is to be recommended because dehorned cattle are more easily cared for than those with horns, and because dehorned cattle enjoy life better. "A great deal of suffering is prevented by the removal of horns."

2. The best time to dehorn cattle is during cold weather when there will be no trouble from flies.

3. To dehorn mature animals, clippers should be used that will remove the horn perfectly at a single stroke and in a moment of time.

4. With suitable clippers properly used, the operation is simple and very quickly performed.

5. When it is skillfully performed, animals do not give evidence of great suffering as an effect of dehorning. The tissues injured in dehorning are not very well supplied with nerves and they are quickly cut through. Good evidence that dehorning is not very painful is the fact that cattle will resume feeding immediately after being operated on, and the yield of milk in cows is not preceptibly affected. Compared with castration of colts and calves, dehorning may be considered painless.

6. Those who are familiar with the operation of dehorning and the results of it are its most enthusiastic advocates.

7. To prevent the growth of horns, calves under three weeks of age can have the embryo horns removed with one stroke of a sharp knife, or they can be treated with a caustic sufficiently powerful to destroy them.

8. In the past, efforts have frequently been made to prevent the practice of dehorning on the ground that it caused needless pain. It would seem to us that efforts can now better be expended by endeavoring to have the last relic of a horn removed from our domestic cattle, who ceased to need them when they

came under the protection of man. Horns may sometimes be ornamental, but it is evident that they are usually useless, expensive and dangerous luxuries.

Bulletin No. 42.

ORNAMENTING HOME GROUNDS.

W. M. Munson.

A constantly recurring problem in New England, is, How shall we keep the boys on the farm? The answer is not easy, but more people are driven from the farm by its isolation, loneliness and lack of tasteful surroundings than by any other cause. If the boys and girls go away to the academy for a time and get a taste of village or city life, the contrast when they return to the old farm is often too strong.

LOCATION.

In building a new house, consider well its location. Don't build where the old one was simply because the barns are there, —though, of course, other things being equal, the barns should be near the house. Healthfulness is of the first importance, so be sure that the location of the residence is such that perfect drainage is secured. Other things being equal, a southern or southeastern aspect is most desirable.

If possible, make use of natural groves or scattering trees and of shelter-belts or wind breaks, and place your buildings near them. Nothing you can plant will be so satisfactory as the native forest trees. If there is not a natural shelter of trees, by all means provide one.

THE LAWN.

A good lawn is the most essential element of beauty in any grounds and in these days of cheap lawn mowers there is no excuse for not having a neat lawn in front of the humblest dwelling. It is very little more work to leave the surface of the ground smooth after the final grading about the buildings than

it is to leave it rough and uneven. Arrange, if possible, to have a few inches of good loam on the surface when the grading is completed, and in any case, make a liberal application of well rotted stable manure. After thorough preparation and raking with a hand rake, seed very thickly, using three to five bushels of seed per acre. After the seed is sown, roll and if late in the season, or the soil is very dry, mulch with chaff or fine manure or leaf mould. Keep the grass closely clipped during the summer. In this way only can the weeds be kept down and a thick velvety turf be formed. In the latter part of the season it is well to let the grass become longer, for the double purpose of strengthening the roots and of serving as a mulch during the winter.

The best grasses for a lawn are Kentucky blue grass and red top, with a slight admixture of white clover on heavy soils. Rhode Island bent is also a valuable grass for heavy clay soils. On a sandy loam, Kentucky blue grass alone will be found as satisfactory as anything.

As to the care of the lawn but little need be said. In the spring it is well to rake off dead leaves and roll the ground, but the practice of burning over the lawn is not to be recommended. A lawn mower is necessary to insure good results, but a very good machine can be procured for $5, and the labor of mowing in this way is very light.

THE FLOWER GARDEN.

While, as a rule, better results may be obtained for the same expenditure of time and labor by using shrubs and perennials, the old fashioned flower garden of our grandmothers is not out of place on the farm. In many cases the taste—or lack of taste—of the occupants of a home are here most vividly portrayed. I go to one place and the blaze of color is enough to blind one. Red reigns supreme! Geraniums, salvias and coleus vie with hollyhocks, phlox and poppies in the effort to dazzle the beholder, while possibly nasturtiums and zinnias endeavor to add color to the scene.

A neighbor may be of a sunny nature; in which case the yellows predominate. Buttercups, marigolds and sunflowers hold sway. Perhaps to please an odd fancy, yellow sweet sultan

holds a place in one corner and golden button timidly holds up its head in the background, while tiger lily and hemerocallis dispute the right to exclusiveness.

Possibly a third neighbor is inclined to have the "blues," and then we find asters and larkspurs, bachelor's buttons, day lilies, irises and tradescantia galore.

How much better the effect would be if these different colors could be united and toned down, not thrown together in crazy patchwork, but harmonized. In general the "flower garden" should be at one side and a little to the rear of the house rather than directly in front. One suggestion with reference to the display of taste in arranging flowers should be made. Although "fashion" may sanction the practice, do not torture your neighbors by arranging a display of pots and kettles, wash-tubs and churns painted a glaring red, in solemn array before the house —as if to remind passers by of the blood of the martyrs.

WHAT TO PLANT.

The selection of trees and shrubs for planting is always perplexing. A few general principles may aid in solving the problem:

1. Do not attempt too much. Grounds that are crowded, even though the plants of themselves may be choice, have the appearance of an over-dressed person.

2. Do not discard native plants because they are "common." The oaks, maples, hickories and elms; the viburnums, dogwoods, roses and sumacs are unsurpassed in their respective classes. We might name further the hawthorns, the wild crab, the wild cherry and plum, the shadbush, the tamarack, the white ash and many others of special value and easy to be obtained.

3. Do not invest freely in untried things. If you have enterprising and experienced neighbors, consult with them before ordering nursery stock. Otherwise correspond with some reliable nursery firm or with some person in whose judgment you have confidence for advice in specific cases. It is usually safer to place an order directly with some reliable firm rather than with an agent. As a rule you will pay an agent 50 to 100 per cent more than the same goods would cost if purchased direct, and are less likely to receive them in good condition. It is

often practicable for several neighbors to unite in sending an order and thus get wholesale rates.

4. In making a selection of flowering trees and shrubs, aim to secure a succession of bloom, in order that the grounds may be attractive all summer. Among the earliest flowering hardy shrubs are Daphne mezereum and the Forsythias which bloom before putting forth leaves—usually about the first of May. Following these shrubs are the magnolias, the red bud or judas tree, the hawthorns, the apple and the cherry among small trees. The magnolia will succeed only in the southern counties. Some of the best second early shrubs are the azalias, bush honeysuckle, Japan quince, double flowering plum, flowering almond, lilacs in variety and the earlier spiræas—especially *Van Houteii, prunifolia* and *Thunbergii.* A little later come the weigelas and mock orange (*Philadelphus*) and the Japanese *Rosa rugosa.* In late summer we have the late spiræas—as *Bumalda, Billardi, Callosa,* etc.,—the "smoke bush" (*Rhus cotinus*) and, best of all for massing, the hardy hydrangea.

The brightness produced by bulbs and hardy perennials will well repay a small outlay in this direction. In earliest spring we have the christmas rose (*Helleborus niger*), the snowdrops (*Galanthus*), crocuses and pansies. A little later tulips and hyacinths appear, and these are followed by columbines, lily-of-the-valley, "bleeding heart" (*Dicentra*) and peony. In summer and early fall, the Japan anemone, the golden columbine (*Aquilegia chrysantha*) the foxglove, hollyhock, plantain lily (*Funkia*) and the numerous species and varieties of true lilies are all very effective and are easy of culture.

WHEN TO PLANT.

But for the difficulty of obtaining well matured stock in the fall, I should advocate setting most trees and shrubs in September and October; because of this difficulty, however, spring planting is usually advisable. All planting should be done just as early in the spring as possible, that the trees or shrubs may become well established before the leaves are put forth.

Hardy herbaceous perennials such as phlox, digitalis, hollyhock, columbine, etc., should, as a rule, be planted in September. The same is true of most bulbous plants, including the

crocus, hyacinth, lilies, tulips, etc. The gladiolus is usually set in spring.

HOW TO PLANT.

In working with trees and shrubs, remember that a plant is a living organism and is as truly sensitive to neglect or ill treatment as is an animal. In handling nursery stock, always be careful to keep the roots moist. When received from the nursery the bundles should at once be opened and the plants carefully "heeled in." In case any of the plants are very dry and withered, they should be completely covered with earth for several days. In this way many plants which if set immediately would die, may be saved.

In removing plants from the nursery, many of the roots will necessarily be injured, rendering the plant unable to supply the moisture lost by evaporation from the leaf surface. Hence the top of the tree or shrub should be severely cut back at the time of transplanting.

As a rule, a tree or shrub should not be set deeper than it sat before removal and the hole should be large enough so that none of the roots need be cramped. If the soil is not in good condition, the labor of carting in good loam, in which to set the plants, will be well expended.

If but few trees or shrubs are to be set, it is well to use water in settling the earth about the roots. In any case, tramp the soil firmly and leave a slight mound about the base of the tree.

If the season is late, or if the soil is very dry, the roots should always be mulched. Any coarse litter that will shade the ground will answer for this purpose—coarse manure, leaves, straw, sawdust or even boards, will answer.

ARRANGEMENT.

The effective arrangement of trees and shrubs is often a most difficult problem. One of the first things to accomplish is the screening of outbuildings and other unsightly objects. The best plants for this purpose are evergreens—especially those which appear best at a distance, as Norway spruce, Austrian pine or arbor vitae (white cedar). It is not necessary that the planting be done in formal belts or hedges. Irregular groups,

so arranged that the view is obstructed, are better than formal hedges. A trellis covered with vines may often be made effective and attractive as a screen.

There may properly be a border of low growing shrubbery next to the house and it is well to plant a vine of some sort by the piazza. Nothing is better for this purpose than the common woodbine or Virginia creeper. Akebia and actinidia, two new Japanese climbers are also good. In general, a better effect is produced by planting in masses and borders, than by dotting the plants here and there over the lawn. By the first method a picture is created with the residence as the central object, and one sees the grounds as a whole. The other method is meaningless and the effect produced is that of an orchard or nursery.

SOME NATIVE TREES AND SHRUBS VALUABLE FOR PLANTING.

The following list of trees and shrubs includes only those which are most common in our forests and which may thus be obtained at slight expense.

EVERGREEN TREES.

Arbor Vitae, or white Cedar (*Thuja occidentalis*, L.).
Hemlock (*Tsuga Canadenis*, Carr.).
Pine, White (*Pinus strobus*, L.).
Pine, Norway (*P. resinosa*, Ait.).
Spruce, White (*Picea alba*, Link.).
Black (*P. niger*, Link.).

EVERGREEN SHRUBS.

Juniper (*Juniperus communis*, L.).
Laurel, Mountain Laurel (*Kalmia latifolia*, L.).
Laurel, Sheep Laurel (*Kalmia augustifolia*, L.).

DECIDUOUS TREES.

Ash, White (*Fraxinus Americana*, L.).
Basswood (*Tilia Americana*, L.).
Beech (*Fagus ferruginea*, Ait.).
Birch, Black or Cherry B. (*Betula lenta*, L.).
Birch, Yellow B. (*Betula lutea*, Michx.).
Gray B. (*Betula populifolia*, Ait.).
Bird Cherry (*Prunus Pennsylvanica*, L.).
Black Cherry (*Prunus serotina*, Ehrh.).
Chestnut (*Castanea Americana*, Watson.).
Elm, White or American (*Ulmus Americana*, L.).
Hawthorn (*Cratægus coccinea*, L.).
Hackmatack, Tamarack or "Juniper" (*Larix Americana*, Michx.).
Maple, Rock or Sugar M. (*Acer saccharinum*, Wang.).
White or Silver M. (*Acer dasycarpum*, Ehrh.).
Red, Soft or Swamp M. (*Acer rubrum*, L.).
Mountain Ash (*Pyrus Americana*, DC.).
Oak, White (*Quercus alba*, L.).
Scarlet (*Quercus coccinea*, Wang.).
Plum, "Pomegranate" (*Prunus Americana*, Marsh.).

DECIDUOUS SHRUBS.

Black Alder or Winterberry (*Ilex verticillata*, Gray.).
Chokeberry (*Pyrus arbutifolia*, L.).
Choke-cherry (*Prunus Virginiana*, L.).
Dockmackie or Maple-leaved Arrow-wood (*Virburnum acerifolium*, L.).
Dogwood, Red Osier (*Cornus stolonifera*, Michx.).
Elder, Common or Black E. (*Sambucus Canadenis*, L.).
Red E. (*Sambucus racemosus*, L.). (?)
High-bush Cranberry (*Viburnum Opulus*, L.).
Hobble-bush (*Viburnum lantanoides*, Michx.).
Honeysuckle (*Lonicera ciliata*, Muhl.).
(*Diervilla trifida*, Moench.).
Meadowsweet (*Spiraea salicifolia*, L.).
Mountain Maple (*Acer spicatum*, Lam.).
Mountain Holly (*Nemopanthes fascicularis*, Raf.).
New Jersey Tea (*Ceanothus Americanus*, L.).
Rose (*Rosa blanda*, Ait.).
(*Rosa lucida*, Ehrh.).
(*Rosa humilis*, Marsh.).
Sheep Berry (*Viburnum Lentago*, L.).
Staghorn Sumach, (*Rhus typhina*, L.).
Thimble Berry (*Rubus odoratus*, L.).
Witch Hazel (*Hamamelis Virginiana*, L.)

CLIMBING VINES.

Bittersweet (*Celastrus scandens*, L.).
Clematis, Virgin's Bower (*Clematis Virginiana*, L.).
Grape (*Vitis Labrusca*, L.).
Virginia Creeper (*Ampelopsis quinquefolia*, Michx.).

BULLETIN No. 43.

FERTILIZER INSPECTION, 1898.

The bulletin gave an outline of the law regulating the sale of commercial fertilizers, the manufacturer's guarantees and the analyses of manufacturer's samples, but as these figures are of only passing value they are omitted here.

BULLETIN No. 44.

FEEDING STUFF INSPECTION.

This bulletin gave the analyses of samples of feeding stuffs coming under the law, collected during January and March, 1898. The figures, so far as they are of permanent value, will be found under "Inspection for 1898" beyond.

BULLETIN No. 45.

FERTILIZER INSPECTION, 1897.

The bulletin gave the manufacturer's guarantees and the analyses of samples collected by the Station, but as these figures are of only passing value they are omitted here. Under "Inspections for 1898," beyond, the requirements of the law and the way it was observed during the year are given.

Bulletin No. 46.

SOME ORNAMENTAL PLANTS FOR MAINE.

W. M. Munson.

The ornamentation of rural homes is of the highest importance to the people of Maine, not only as a means of adding to the comfort and pleasure of the home life, but as an attraction for the increasing numbers of summer visitors and as a means of enhancing the value of farm property.

Concerning methods of planting and culture of trees and shrubs, but little need be said at this time. Some notes have been published by the Station in Bulletin 42.

In general it may be said that to get satisfactory results, shrubs and other flowering plants should receive as good treatment as corn and potatoes. When once established, shrubs and perennial herbs require much less care than do annuals, but during the first year or so, careful attention will be well repaid.

In determining what to plant, several points must be considered: First of all, the plant must be hardy. Some of the finest shrubs of Massachusetts and New York are utterly unsuited for the climate of Maine. For this reason the use of native plants is to be recommended so far as possible, and few exotics are superior to the common viburnums, dogwoods, elders, sumachs and laurels. Other points to be considered are: season, habit, beauty of foliage, flower and fruit. If possible, such a selection should be made as will afford a succession of bloom or other attractive qualities through the season. For instance, among flowering shrubs, the earlier spiræas, may be followed by double flowering plum, Tartarian honeysuckle, and Japan quince, these in turn by lilacs, weigela, and later by roses, mock orange and hydrangea. To this list may be added the common high bush cranberry and the dwarf Juneberry or shadbush from the pasture.

For beauty of foliage, the golden elder and the golden syringa are unsurpassed. Purple berberry, (*Spiræa Thunbergii,*) and the common staghorn sumach are also to be recommended. The last is specially valuable for its rich coloring in the fall. For the best effects it should be planted in masses, on

rich soil, and cut to the ground each year. It will then grow up six to eight feet each season, and give a rich tropical effect. Other native plants which may be mentioned in this connection, are the thimble berry (*Rubus odoratus*), valuable alike for flower and foliage; hobblebush (*Viburnum lantanoides*), with its large, rich, green leaves; dogwood or red osier (*Cornus stolonifera*), which is specially valuable in winter for the contrast afforded by the bright red shoots.

Of shrubs valuable for their fruit, we may name Tartarian honeysuckle, the strawberry bush (*Euonymus*), *Rosa rugosa*, snowberry (*Symphoricarpus*), high-bush cranberry (*Viburnum opulus*), black alder or winterberry (*Ilex verticillata*). The last two may be obtained from the woods and swamps in many sections of the State.

SOME OF THE BEST TREES.

The trees named below have been growing on the University campus for several years and have proved reliable in this section of the State.

The Elm: Several species of elms are found in New England but the most valuable for ornamental purposes is the native white or American elm, (*Ulmus Americana*), which has justly been called "Queen of American Trees." A somewhat moist location is best suited for this species, which, where uninjured, grows very rapidly and is of most attractive form and habit. The English elm (*Ulmus campestris*), is somewhat larger than the American species and is of very different habit—in this respect resembling the oaks. The leaves are smaller, more regularly cut, and darker; the bark is also darker colored. The Scotch or Wych elm (*Ulmus montana*), is one of the most valuable of the foreign species, but it is little known in this country. There are on the University campus some interesting hybrids between this and the American species.

The Maple: The maples are among the most valuable and popular of trees for ornamental planting. The sugar maple (*Acer saccharinum*) is too well known to require description. It is most at home, and grows most rapidly, on gravelly soil. The white or silver maple (*Acer dasycarpum*) is not quite as early in leaf as the sugar maple, nor is the general appearance so

pleasing. It is, however, of very rapid growth and will thrive in a variety of soils. A variety of this species, Wier's cut leaved weeping maple, is also valuable. The red or scarlet maple (*Acer rubrum*) is not so widely planted as its merits deserve. Like the silver maple, it grows naturally on low wet ground, but it will thrive in any soil or situation. Its bright red buds in spring and its scarlet foliage in fall, combine to make it specially desirable. All of the maples named, except Wier's, are to be found growing wild in the forests throughout the State.

The Beech: Although of very different style, the beech (*Fagus ferruginea*) ranks with the elm as a hardy and attractive ornamental tree. Its roots grow near the surface and it will thrive in rocky soil.

The Chestnut: The native chestnut (*Castanea Americana*), one of the glories of the rocky hill-sides of Southern New England, is perfectly hardy in Maine and is well worthy of attention. It is particularly adapted to rocky situations or loose gravelly soils. The horse chestnut (*Æsculus Hippocastanum*) is hardy and grows rapidly. It is valuable for planting by the roadside.

The Linden: The American linden or basswood, (*Tilia Americana*), is valuable for use where an immediate effect is desired. It is hardy, of good form, and grows rapidly. The European species (*Tilia Europæa*), is of smaller size and has smaller, darker foliage than the other.

The Birch: The lightness, grace and delicacy of the birches commend them to the attention of every planter. The cut-leaved weeping birch (*Betula Alba* var.) is a general favorite wherever planted. The American species start into leaf very early in the spring and many of them will grow under the most untoward circumstances. The best are the black or cherry birch (*Betula lenta*), the yellow (*B. lutea*), and the gray (*B. populifolia.*)

The Poplars: The poplars are all rapid growers and are valuable for giving an immediate effect—some species often making a growth of six feet in a single year. All are short lived, however, and their greatest beauty is attained while young.

The Oak: While oaks which have attained large size are among the most attractive of trees, the finest species are late in leaf and of slow growth. The most valuable native species are

the white oak, *Quercus alba,* and the scarlet oak, *Quercus coccinea.*

THE MOST VALUABLE SHRUBS.

The number of flowering shrubs which will thrive in Maine is comparatively limited. The following have proved satisfactory on the grounds of the University for several years. It is worthy of note that the shrubs which are the most commonly known, and that may be obtained the cheapest, are generally the best, or have the greatest number of good qualities.

The Spiræa: Of the spiræas, the best are *S. Thunbergii* and *S. Van Houttei.* The first has narrow yellowish green leaves and blossoms very early in the spring, before the leaves are fully out. The other blooms about the middle of June and is specially valuable. The flowers are white and appear in great profusion. *S. Reevesii* is similar to the Van Houttei, but a little earlier. *S. Bumalda* is one of the best pink varieties. It commences to bloom about the middle of June and continues all summer. *S. Prunifolia,* "Bridal Wreath," is another very good white variety; one of the earliest.

The Lilac: This old favorite is again popular. Some of the newer named varieties which are specially good are the following: *Syringa vulgaris,* the true old garden lilac, has varied greatly under cultivation and there are now more than twenty-five named varieties of this species. Some of the best of these are Charles X, Louis Spath, Princess Marie and Senator Vollard, among the purples; and Marie Legraye, and Dr. Stockhardt among the whites. *Syringa Persica,* the Persian lilac, has loose graceful heads of flowers in great profusion. The habit of the plant, as well as of the flower cluster, is more open and graceful than that of the common lilac. The white form is specially valuable. *Syringa Josikæa* is a very distinct species with large, shining foliage and dark, lilac colored flowers. It blooms after many others are out of flower. *Syringa Rothmagensis* is similar in habit to the Persian lilac, but the flowers are dark, reddish purple. It is said to be a cross between *Syringa vulgaris* and *Syringa Persica.*

The Viburnum: Besides the old fashioned snowball, *Viburnum opulus,* var. *sterilis,* which is always popular and needs no

description, the best are: *Viburnum Nepalense,* which is a strong grower, though of compact form, and having large, thick leaves; *Viburnum prunifolium,* "black haw," a large growing shrub, bearing flat clusters of white flowers early in June, followed by black fruit in the fall; also the maple leaved virburnum (*V. acerifolium*), a low growing shrub, bearing flat heads of white flowers about the middle of June. The last is excellent for growing in masses, especially in shady places. The Japanese snowball (*Viburnum plicatum*) is one of the best of shrubs. Of upright bushy growth, firm dark foliage, and bearing its white flowers in great profusion, it well deserves a place in every collection. It is in many ways much superior to the old snowball, one special point in its favor being its freedom from lice.

The Mock Orange: The mock orange or "syringa" (*Philadelphus*) is one of the finest of shrubs, whether grown singly or in masses. It is hardy, early in leaf, and graceful in habit. *Philadelphus coronarius* is the one most commonly grown, and it has fragrant orange-like flowers, which appear late in June in this locality. *P. Zeyheri* is more vigorous and has larger, but less fragrant and less abundant flowers than the preceding. Gordon's syringa, *P. Gordonii,* somewhat smaller and more slender than the others, blooms a month later but its flowers, though large, are scentless.

Some other shrubs which have proved valuable at the University are: bladder senna (*Colutea*), flowering currant (*Ribes aureum* and *R. Gordonii*), Japanese rose (*Rosa rugosa*), golden elder, (*Sambucus canadensis aurea*), thimble berry (*Rubus odoratus*), tartarian honeysuckle (*Lonicera Tartarica*), weigela (*Diervilla florida*), white fringe (*Chionanthus Virginica*), and the hydrangeas (*H. paniculata grandiflora* and *H. vestita*).

TRIED AND FOUND WANTING, OR OF DOUBTFUL VALUE.

Among the trees and shrubs which thus far have proved unsatisfactory in Eastern Maine, the following may be mentioned: green ash (*Fraxinus viridis*); the magnolias, except *Magnolia Soulangeana;* the Japanese chestnuts; tamarisk (*Tamarix Africana (?);* cornelian cherry (*Cornus mas);* (Deutzia) (*Deutzia scabra* and *D. gracilis);* golden bell (*Forsythia);* burning bush (*Rhus cotinus*).

A FEW HERBACEOUS PERENNIALS.

The number of herbaceous perennials commonly grown in this State is comparatively limited; some of the most valuable, however, are the peony, iris, lily-of-the-valley, bleeding heart (*Dicentra*), and foxglove.

The peony, *Pæonia officinalis,* is specially valuable when planted in masses. It gives a profusion of bloom about the middle of June, and is perfectly hardy. It is valuable alike for landscape effects and for cut flowers. There are more than a hundred named varieties, but for ordinary purposes unnamed sorts answer very well and are much less expensive.

For a short time in early June, before the peonies appear, the varieties of *Iris Kœmpferi* are specially valuable. Like the peony, and most other herbaceous perennials, this should be planted in September.

Among the plants which bloom very early in the spring, Christmas rose (*Helleborus niger*), and "bleeding heart" (*Dicentra*), should not be forgotten. Feverfew or pyrethrum, (*Chrysanthemum Parthenium,*) is another plant that should be in every collection. Its pure white double flowers, contrasting with the delicately cut foliage, add much to the border. The tall pyrethrum, (*Chrysanthemum uliginosum* or *Pyrethrum uliginosum*), which blooms in September, is also a valuable plant. It grows about three or four feet high and its large daisy-like flowers are very conspicuous. It is a vigorous grower and may readily be propagated by dividing the clump.

The gas plant (*Fraxinella*) should not be omitted from the list of useful perennials. The handsome ash-like foliage is attractive at all seasons. Golden columbine, (*Aquilegia Chrysantha,*) is one of the most valuable yellow flowering plants for summer. The double sunflower, (*Helianthus Multiflorus,*) which grows about three or four feet high, is also valuable. Later in the season the Japanese anemones with their single dahlia-like flowers are valuable. In this connection the dahlia may also be mentioned. Though the roots must be taken up each year, this plant is justly popular. Lily-of-the-valley, foxglove, phlox, larkspur, and some other old garden favorites, easy of culture and prolific of bloom have not been mentioned, nor has anything been said of the numerous species and varieties of lilies. These, however, may well be included in every collection.

Bulletin No. 47.

WHEAT OFFALS SOLD IN MAINE IN 1898.

Chas. D. Woods.

The refuse products in the milling of wheat are very important cattle foods. With the exception of Indian corn, whole and ground, there is probably no other class of foods used so largely in this State as food for dairy stock. All of the milling products of wheat are, under the law, exempt from inspection. In order that the character of these feeds might be investigated, the Station inspectors were directed in January and again in November, 1898, to take samples of all the distinct brands of brans, middlings, mixed feeds, and kindred substances they might find exposed for sale. About 150 samples were collected. As this class of feeds are, in addition to their mineral matters, of chief importance as a source of nitrogen, only the protein was determined in them. All suspicious samples were examined under the microscope, but in no instance was foreign matter found that indicated adulteration. In a few cases oat and barley hulls were observed but in no greater amount than sometimes occurs in wheat.

The class of mill products that are particularly deceptive and which seem to be the "catch all" are the so-called middlings. From poorer in protein than the poorest brans, they are in some instances better than the high grade feed flours. Some of these are apparently mixed with nearly worthless refuse materials while others are strictly high grade goods. No one can afford to buy this class of goods unless their quality is guaranteed. Middlings that carry 18 to 20 per cent of protein are very desirable as a feed, but those that carry only 12 or 13 are little better than oat hulls. Unfortunately there seems to be no relation between the price asked and the true feeding value. The dealers in these goods profess to know nothing of their composition. The protection alike of dealers and consumers seems to demand that this class of feeds be placed under the requirements of the feeding stuff law.

ANALYSES OF BRANS, ETC., COLLECTED IN 1898.

Station number.	Manufacturer or Dealer.	Sampled at	Date of sampling.	Name of Feed.	Protein—per cent.
			1898		
8207	Albion Milling Co.	Bucksport	Jan.	Winter Wheat Bran	13.9
8246	Albion Milling Co.	West Minot	Jan.	Winter Wheat Bran	13.6
8446	Albion Milling Co.	Farmington	Oct.	Winter Wheat Bran	13.9
8258	Stott's Flour Mills.	Richmond	Jan.	Stott's Pure Winter Wheat Bran	14.6
8203	Stott's Flour Mills.	Dexter	Jan.	Stott's Pure Winter Wheat Bran	15.1
8222	Valley City Milling Company	Guilford	Jan.	Winter Wheat Bran	15.7
8248	J. L. Briggs	Poland	Jan.	Pure Winter Wheat Bran	14.3
8405	Wm. A. Coombs.	Dexter	Sept.	Winter Wheat Bran	15.2
8444	C. P. Chapman	Dover	Oct.	Winter Wheat Bran	14.9
8253	C. A. Whitehouse	North Leeds	Feb.	Spring Wheat Bran	16.2
8224	Albion Milling Co.	Foxcroft	Jan.	Bran	15.2
8260	Acme Milling Co.	Bath	Jan.	Acme Bran	15.3
8198	Pillsbury's Mill	Belfast	Jan.	Pillsbury's Bran	15.5
8233	Pillsbury's Mill	Norway	Jan.	Pillsbury's Bran	15.6
8263	Pillsbury's Mill	Bowdoinham	Jan.	Pillsbury's Bran	15.6
8264	Pillsbury's Mill	Houlton	Jan.	Pillsbury's Bran	15.9
8411	Pillsbury's Mill	Bangor	Sept.	Pillsbury's Bran	15.3
8421	Pillsbury's Mill	Damarisc'ta M'ls	Oct.	Pillsbury's Bran	15.3
8454	Pillsbury's Mill	Eastport	Oct.	Pillsbury's Wheat Bran	15.1
8205	F. W. Stock	Newport	Jan.	Bran	14.9
8230	F. W. Stock	Hiram	Jan.	Bran	15.2
8239	F. W. Stock	Canton	Jan.	Bran	14.8
8427	F. W. Stock	Wiscasset	Oct.	Bran	15.4
8439	F. W. Stock	Canton	Oct.	Bran	15.0
8201	North Dakota Milling Association	Orrington	Jan.	Bran	16.2
8208	Washburn Crosby Company	Bucksport	Jan.	Coarse Bran	15.6
8220	Washburn Crosby Company	Damariscotta	Feb.	Coarse Bran	15.7
8213	D. B. Gardner & Co.	West Pembroke	Jan.	Wheat Bran	15.5
8216	L. H. Phelan	Calais	Jan.	Wheat Bran	15.5
8227	E. A. Ireland	Dover	Jan.	Bran	17.4
8231	Wm. Listman Milling Company	Cornish	Jan.	Hiawatha Bran	16.5
8237	Wm. Listman Milling Company	Norway Lake	Jan.	Hiawatha Bran	15.1
8244	Voigt Milling Co.	Mechanic Falls	Jan.	Choice Bran	16.1
8416	Voigt Milling Co.	Pittsfield	Sept.	Choice Bran	16.6
8441	Voigt Milling Co.	West Paris	Oct.	Choice Bran	15.7
8265	Voigt Milling Co.	Presque Isle	Jan.	Wheat Bran	13.9
8442	Voigt Milling Co.	Milo	Oct.	Bran	15.0
8250	Anchor Milling Co.	Hollis Center	Jan.	Bran	16.4
8249	E. S. Woodworth & Company	South Paris	Jan.	Snow's Flaky Bran	16.3

ANALYSES OF BRANS, ETC.—CONTINUED.

Station number.	Manufacturer or Dealer.	Sampled at	Date of sampling.	Name of Feed.	Protein—per cent.
8414	E. S. Woodworth & Company.........	Bucksport........	Sept.	Snow's Flaky Bran.	15.6
8433	E. S. Woodworth & Company.........	Sebago Lake.....	Oct..	Snow's Flaky Bran..	16.1
8457	E. S. Woodworth & Company.........	Island Falls......	Oct..	Snow's Flaky Bran..	15.6
8406	Stott's Flour Mills.	Corinna	Sept.	Stott's Bran.........	14.7
8416	Stott's Flour Mills.	Orrington	Oct..	Stott's Bran.........	15.1
8425	Vannah & Chute...	Waldoboro	Oct..	Wheat Bran	15.1
8431	E. D. Walker......	East Brownfield.	Oct..	Kansas Wheat Bran	15.2
8432	Shelby & Senior...	East Brownfield.	Oct..	Shelby Mill Bran...	15.9
8435	Milford Roll Mills.	Buxton Center...	Oct..	Pure Bran	14.6
8436	So. Paris Grain Co.	South Paris	Oct..	C. Bran..............	15.8
8448	F. L. Butler	Farmington......	Oct..	Bran.................	17.9
8450	No. West. Consolidated Milling Co.	Eastport	Oct..	Wheat Bran	14.3
8266	A. Cox	Presque Isle	Jan..	Buckwheat Bran...	14.7
8267	H. A. Edwards....	Caribou	Jan..	Buckwheat Bran (Roller Process...	16.1
8193	Blish's Milling Co.	Winterport	Jan..	Blish's Mixed Feed.	16.1
8197	Blish's Milling Co.	Belfast	Jan..	Blish's Mixed Feed.	15.5
8415	Blish's Milling Co.	Pittsfield	Sept.	Blish's Mixed Feed.	16.7
8219	Bliss Milling Co ...	Damariscotta	Feb..	Bliss Mixed Feed ..	15.8
8254	Bliss Milling Co ...	North Leeds......	Feb..	Bliss Winter Wheat Mixed Feed.......	15.8
8194	J. Jenks & Co	Hampden	Jan..	Winter Wheat Mixed Feed.	14.9
8261	J. Jenks & Co......	Bath	Jan..	Winter Wheat Mixed Feed.......	14.5
8434	J. Jenks & Co......	Hiram	Oct..	Mixed Feed.........	14.3
8195	Doten Grain Co....	Hampden	Jan..	Eagle Mixed Feed..	17.4
8196	Anchor Milling Co.	Bangor	Jan..	Anchor Mixed Feed	17.1
8262	F. W. Stock	Orrington	Jan..	M. F. Mixed Feed ..	15.1
8229	F. W. Stock	Hiram	Jan..	M. F. Mixed Feed ..	14.7
8429	F. W. Stock	Wiscasset	Oct..	Mixed Feed.........	15.3
8255	Stott's Flour Mills.	Livermore Falls.	Feb..	Stott's Mixed Feed.	15.1
8206	Lake Superior Mills..............	Newport	Jan..	Superior Mixed Feed....	16.6
8209	Washburn Crosby Company.........	Bucksport........	Jan..	Superior Mixed Feed......	16.7
8238	Washburn Crosby Company.	Canton	Jan..	Superior Mixed Feed...............	16.7
8266	Eldred Mill Co.....	Dexter	Jan..	Pure Mill Feed	14.6
8210	Paris Flouring Co.	Corinna	Jan..	Royal Mixed Feed..	17.5
8236	Wm. Listman Milling Company	Norway Lake....	Jan..	Hiawatha Mixed Feed...............	16.6
8241	Voigt Milling Co ..	Bethel	Jan..	Mixed Feed.........	15.8
8251	Minkota Milling Co	Kennebunk	Jan..	Minkota Mixed Feed	16.8

ANALYSES OF BRANS, ETC.—CONTINUED.

Station number.	Manufacturer or Dealer.	Sampled at	Date of sampling.	Name of Feed.	Protein—per cent.
8199	Acme Milling Co..	Belfast	Jan..	Acme Feed	16.1
8252	Acme Milling Co..	Lewiston.........	Feb.	Acme Feed	16.6
8262	Acme Milling Co..	Bowdoinham	Jan..	Acme Feed	15.6
8426	Acme Milling Co..	Rockland.........	Oct..	Acme Feed	16.8
8449	Acme Milling Co..	Farmington......	Oct..	Acme Feed	16.8
8200	R. P. Moore Milling Company.........	Belfast	Jan..	King Feed	16.1
8217	R. P. Moore Milling Company.... ...	Nobleboro.......	Jan..	King Feed	16.6
8420	R. P. Moore Milling Company........	Damarisc'ta M'ls	Oct..	King Mixed Feed ..	16.2
8409	R. P. Moore Milling Company.........	Newport..........	Oct..	Mixed Feed.........	16.4
8404	Wm. A. Coombs ...	Dexter............	Sept.	Winter Wheat Mixed Feed..... .	15.0
8407	Chapin & Co	Bangor	Sept.	Sterling Mixed Feed......	16.6
8445	Chapin & Co	Guilford	Oct..	Sterling Mixed Feed...............	16.2
8412	Miles & Son	Bangor	Sept.	Mixed Feed.........	14.9
8413	Miles & Son	Bucksport.......	Sept.	Mixed Feed.........	14.9
8276	Saginaw Milling Co	Orrington	Oct..	Mixed Feed.........	14.9
8417	Kent & Senior Co..	Pittsfield	Sept.	Shelby Mills Mixed Feed...............	14.8
8418	Amer. Cereal Co...	Bucksport........	Sept.	Buckeye Wheat Feed.	16.0
8452	Amer. Cereal Co...	Eastport........ .	Oct..	Buckeye Wheat Feed.	15.9
8419	Rex Mill Co	Belfast	Sept.	Mixed Feed.........	16.0
8430	E. L. Dillingham ..	Thomaston.	Oct..	Gold Dust Mixed Feed...............	15.9
8438	So. Paris Grain Co.	South Paris	Oct..	Mixed Feed.........	16.4
8447	P. M. Company	Farmington	Oct..	Michigan Mixed Feed.......	16.1
8211	D. B. Gardner Co ..	West Pembroke .	Jan..	White Middlings...	19.0
8235	J. Jenks & Co......	Norway....	Jan..	Fine White Middlings	12.4
8408	J. Jenks & Co......	Hampden	Oct..	Fine White Middlings	13.5
8423	J. Jenks & Co......	Waldoboro	Oct..	Fine White Middlings	13.6
8277	Saginaw Milling Co	Orrington	Oct..	White Middlings ...	13.1
8437	So. Paris Grain Co.	South Paris	Oct..	White Middlings ...	21.5
8212	D. B. Gardner.. ..	West Pembroke .	Jan..	Brown Middlings ..	18.9
8451	No. West. Consolidated Milling Co.	Eastport....	Oct..	Brown Middlings ..	17.4
8453	No. West. Consolidated Milling Co.	....	Oct..	Brown Middlings ..	17.6
8214	L. H. Phelan	Calais.............	Jan..	Brown Middlings ..	18.5
8204	Pillsbury's Mills...	Newport	Jan..	Pillsbury's Middlings	16.9

ANALYSES OF BRANS, ETC.—CONCLUDED.

Station number.	Manufacturer or Dealer.	Sampled at	Date of sampling.	Name of Feed.	Protein—per cent.
8218	F. W. Stock	Waldoboro	Jan..	(M) Middlings	16.3
8228	F. W. Stock	Hiram	Jan..	Coarse Middlings	15.6
8428	F. W. Stock	Wiscasset	Oct..	Middlings	15.4
8440	F. W. Stock	Canton	Oct..	Middlings	16.0
8225	Stott's Milling Co.	Foxcroft	Jan..	Middlings	17.4
8226	Stott's Milling Co.	Dover	Jan..	Middlings	17.2
8223	Valley City Milling Company	Guilford	Jan..	Winter Wheat Middlings	16.6
8232	Washburn Crosby Company	Norway	Jan..	Flour Middlings	17.4
8259	Washburn Crosby Company	Richmond	Jan..	Standard Middlings	16.9
8240	Voigt Milling Co	Bethel	Jan..	Choice Middlings	17.3
8245	Keeler Bros.	West Minot	Jan..	Red Winter Middlings	17.4
8422	The Walsh De Roo Milling Company	Waldoboro	Oct..	Middlings	17.2
8424	Wm. A. Coombs	Waldoboro	Oct..	Winter Wheat Middlings	15.6
8443	Austed & Burke	Milo	Oct..	Middlings	16.2
8458	Minkota Milling Co	Houlton	Oct..	Middlings "Athlete" Brand	16.6
8221	Pillsbury's Mill	Damariscotta	Feb..	Pillsbury's XX Daisy Feed Flour.	19.5
8247	Pillsbury's Mill	Poland	Jan..	Pillsbury's XX Daisy Feed Flour.	19.8
8257	Pillsbury's Mill	Richmond	Jan..	Pillsbury's XX Daisy Feed Flour.	19.1
8215	Pillsbury's Mill	Calais	Jan..	Pillsbury's XX Daisy Feed Flour.	19.2
8256	No. West. Consolidated Milling Co.	Richmond	Jan..	XXX Comet	20.9

SUMMARY OF ANALYSES OF BRANS, ETC.

	Number of analyses.		Protein—per cent.
Stott's Flour Mills		Highest	15.1
Stott's Bran	4	Lowest	14.6
		Average	14.9
Pillsbury's Mills		Highest	15.9
Pillsbury's Bran	7	Lowest	15.1
		Average	15.4
F. W. Stock's		Highest	15.4
Bran	5	Lowest	14.8
		Average	15.1
Voigt Milling Company's		Highest	16.6
Choice Bran	5	Lowest	13.9
		Average	15.5
E. S. Woodworth & Company's		Highest	16.3
Snow's Flaky Bran	4	Lowest	15.6
		Average	15.9
Winter Wheat Brans		Highest	15.7
All analyses	9	Lowest	13.6
		Average	14.6
All Brans not Marked Winter		Highest	17.9
Wheat Brans	42	Lowest	13.9
		Average	15.6
Blish's Milling Company's		Highest	16.7
Mixed Feed	5	Lowest	15.5
		Average	16.0
F. W. Stock		Highest	15.3
Mixed Feed	3	Lowest	14.7
		Average	15.0
Acme Milling Company's		Highest	16.8
Acme Feed	5	Lowest	15.6
		Average	16.4
R. P. Moore Milling Company's		Highest	16.6
King Mixed Feed	4	Lowest	16.1
		Average	16.3
All Mixed Feeds		Highest	17.5
Resembling Brans	44	Lowest	14.3
		Average	15.9
		Highest	21.5
White Middlings	6	Lowest	12.4
		Average	15.5
		Highest	18.9
Brown Middlings	4	Lowest	17.4
		Average	18.1
		Highest	21.5
Middlings, all kinds	26	Lowest	12.4
		Average	16.6
		Highest	19.8
Pillsbury's XX Daisy Feed Flour	4	Lowest	19.1
		Average	19.4

INSPECTIONS FOR 1898.

Chas. D. Woods.

The Station officers take pains to obtain for analysis samples of all commercial fertilizers and concentrated commercial feeding stuffs coming under the law, but the organized co-operation of farmers is essential for the full and timely protection of their interests. Granges and other organizations can render efficient aid by sending early in the season, samples taken from stock in the market and drawn in accordance with the station directions for sampling.

There is no provision made by law for the analysis of agricultural seeds. Seeds, taken in accordance with the station directions for sampling, will be examined for $1 per sample.

Directions for sampling and blanks for forwarding samples of fertilizers, feeding stuffs and seeds will be sent on application.

The use of commercial fertilizers in the State seems to be somewhat on the increase. From information furnished by most of the manufacturers shipping into the State, a conservative estimate places the amount used in 1898 at 17,000 tons. For the most part there is entire harmony between the manufacturers and their agents and the consumers. In no instance this year has the Station received complaints of quality of goods from the consumers. The demand for low priced goods has increased the number of low grade fertilizers in the market. It is not known if the presence of an increased number of low grade goods indicates a corresponding increase in the sale of this class of fertilizers, but even if it does it is probable that in the most instances the purchaser is obtaining that which he pays for. The low grade goods as well as the high class are for the most part up to or above the minimum guarantee.

Requirements of the Law.

The full text of the law regulating the sale and analysis of commercial fertilizers will be sent on application to the Station. Its chief requirements are as follows:

The Brand. Each package of commercial fertilizer shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.
The name or trade mark under which it is sold.
The name of the manufacturer or shipper.
The place of manufacture.
The place of business of manufacturer or shipper.
The percentage of nitrogen.
The percentage of potash soluble in water.
The percentage of available phosphoric acid.
The percentage of total phosphoric acid.

The Certificate. For each brand of fertilizer a certificate shall be filed annually with the Director of the Station giving the manufacturer's or dealer's name, place of business, place of manufacture, name of brand of fertilizer and the guaranteed composition.

The Manufacturer's Sample. Unless excused by the Director under certain conditions, a sample of each fertilizer, with an accompanying affidavit that this sample "corresponds within reasonable limits to the fertilizer which it represents" must be deposited annually between November 15 and December 15 with the Director of the Station.

The Analysis Fee. The law requires the annual payment to the Director of the Station of an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash, contained or said to be contained in the fertilizer, this fee to be assessed on each brand sold in the State.

Duties of the Director. The law also imposes upon the Director of the Maine Agricultural Experiment Station certain duties, which are:

The issuing of licenses to such manufacturers as comply with the above named requirements.

The analysis of the samples deposited by the manufacturer.

The selection of samples in the open market of all brands of fertilizers sold or offered for sale in the State, with the subsequent analysis of the sample.

The publication of bulletins or reports, giving the results of the inspection.

In accordance with the law, two commercial fertilizer bulletins were printed during the year. The first (43) was published early in March and contained the analyses of the samples received from the manufacturers, guaranteed to represent, within reasonable limits, the goods to be placed upon the market

later. The second bulletin (45) contained the results of the analyses of the samples collected in the open market by the officers of the Station, and was published in October.

A comparison of the percentages guaranteed by the manufacturers' samples and those collected by a Station representative in different parts of the State, shows that, as a rule, the fertilizers sold in the State are well up to the minimum guarantee. In a few instances the particular lots of fertilizers sampled were not quite as good as they should be; there was, however, no case which appeared to be an attempt to defraud. The comparisons indicate that the manufacturers do not intend to do much more than make good the minimum guarantee, and this is all the purchaser can safely expect.

The tabular statement which follows, summarizes the comparisons of manufacturer's and Station samples with the guarantee.

NITROGEN.

Manufacturer's samples.	
Number of samples above guarantee............	119
Number of samples below guarantee............	13
Number of samples .2% or more below guarantee,	4
Station samples.	
Number of samples above guarantee............	112
Number of samples below guarantee............	37
Number of samples .2% or more below guarantee,	20

AVAILABLE PHOSPHORIC ACID.

Manufacturer's samples.	
Number of samples above guarantee............	121
Number of samples below guarantee............	20
Number of samples .2% or more below guarantee,	10
Station samples.	
Number of samples above guarantee............	152
Number of samples below guarantee............	22
Number of samples .2% or more below guarantee,	13

TOTAL PHOSPHORIC ACID.

Manufacturer's samples.	
Number of samples above guarantee............	134
Number of samples below guarantee............	11
Number of samples .2% or more below guarantee,	6

Station samples.

Number of samples above guarantee............	162
Number of samples below guarantee............	15
Number of samples .2% below guarantee........	11

POTASH.

Manufacturer's samples.

Number of samples above guarantee............	126
Number of samples below guarantee............	12
Number of samples .2% or more below guarantee,	4

Station samples.

Number of samples above guarantee............	138
Number of samples below guarantee............	32
Number of samples .2% or more below guarantee,	19

Comparison of guarantees and station samples for three years.

It is important for the purchaser of fertilizers to know how the goods have compared with the guarantee, not merely for one year but for several years. Formerly we have printed a table comparing the analysis of the manufacturers' and Station samples for the year with the guarantee. In the table which follows there is given a comparison of the analyses of the samples collected by the Station for the years 1896, 1897 and 1898 with the guarantee of the manufacturers. When the guarantee has been changed in 1898 from that of the previous years the fact is indicated by a †, and where more than one analysis of the same brand was made in 1898, this is indicated by a *.

In studying the table of comparison of guarantees of the Station samples for three years, it will be found that many goods run quite uniform year after year. This is particularly true as regards phosphoric acid and is readily understood when it is remembered that the "superphosphate" is the starting point and that the materials furnishing the nitrogen and potash are added to this. The potash and nitrogen are the more expensive substances in fertilizers and greater variations in composition are found in these constituents.

COMPARISON OF GUARANTEES AND STATION SAMPLES FOR 3 YEARS.

Name of Fertilizer.	Nitrogen.				Available Phosphoric Acid.				Potash.			
	Found.			Guaranteed.	Found.			Guaranteed.	Found.			Guaranteed.
	1896.	1897.	1898.		1896.	1897.	1898.		1896.	1897.	1898.	
	%	%	%	%	%	%	%	%	%	%	%	%
Americus Ammoniated Bone Superphosphate	2.85	2.56	*2.50	2.47	9.31	9.21	*9.79	9.0	2.22	2.20	*2.19	2.0
Americus Corn Phosphate	2.21	2.15	2.19	2.06	8.78	8.85	9.11	9.0	2.81	1.81	1.74	1.5
Americus Potato Manure	2.33	2.28	*2.04	2.06	8.83	9.08	*9.11	8.0	3.26	3.32	*2.95	3.0
Baker's Special Complete Potato Manure	.....	....	3.73	3.30	.....	.....	6.43	5.8	.....	.....	9.37	10.0
Baker's Vegetable, Vine and Potato Manure	.....	.....	1.80	1.65	.....	.....	6.81	5.5	.....	.....	11.13	12.0
Bay State Defiance Phosphate	.....	.91	.96	.82	.....	8.08	8.12	7.0	.....	1.40	1.49	1.0
Bay State Fertilizer	2.67	2.96	*2.42	2.47	9.86	9.29	*9.19	9.0	2.14	2.22	*2.07	2.0
Bay State Fertilizer "G. G."	2.39	2.33	2.00	1.85	8.88	9.95	8.94	8.5	2.07	2.28	2.35	2.0
Bay State Fertilizer for Seeding Down	1.08	1.21	1.30	1.03	9.29	8.19	9.16	8.0	1.93	2.01	2.22	2.0
Bowker's Ammoniated Dissolved Bone	2.03	1.54	1.78	1.50	7.01	7.66	6.85	8.0	2.25	2.41	2.46	2.0
Bowker's Bone and Wood Ash Fertilizer	.....	..	1.65	1.50	.....	.....	6.82	6.0	.....	.....	2.60	2.0
Bowker's Corn Phosphate	.....	1.58	1.55	1.60	.....	7.30	9.85	7.0	....	2.23	2.66	2.0
Bowker's Farm and Garden Phosphate	1.80	1.55	1.71	1.50	8.35	8.32	8.29	8.0	2.21	2.25	2.45	2.0
Bowker's Fresh Ground Bone	.....	.....	3.22	2.25	.....	.....	23.07	.....	.....	.....	.....	.....
Bowker's High Grade Fertilizer	.....	2.53	2.24	2.25	.....	9.60	8.66	8.0	.....	4.62	4.43	4.0
Bowker's Hill and Drill Phosphate	2.43	2.71	2.40	2.25	10.18	9.94	9.14	9.0	2.34	2.22	2.38	2.0
Bowker's Market and Garden Fertilizer	2.48	.....	2.30	2.25	4.48	.....	4.91	6.0	10.11	.....	10.07	10.0
Bowker's Potash or Staple Phosphate	.....	.....	.98	.75	.....	.....	9.81	8.0	.....	.....	3.29	3.0
Bowker's Potato and Vegetable Phosphate	.....	1.79	1.72	1.50	.....	8.15	7.99	8.0	.....	2.25	2.41	2.0
Bowker's 6% Potato Fertilizer	1.01	.95	.90	.75	8.50	7.62	7.19	7.0	5.99	6.89	7.30	6.0
Bowker's Special Fertilizer, Potato and Vegetable	.....	2.51	2.47	2.25	.....	9.10	8.01	8.0	.....	4.67	4.29	4.0

Bowker's Square Brand Bone and Potash	1.86	.....	1.71	1.50	5.10	.....	6.03	6.0	2.48	.....	2.50	2.0
Bowker's Superphosphate with Potash for Grass and Grain	.43	.....	.30	.60	10.69	10.01	9.38	10.0	1.60	4.00	2.17	2.0
Bowker's Sure Crop Phosphate	1.09	.....	.98	.75	9.83	.....	9.48	8.0	1.33	.....	1.33	1.0
Bowker's 10% Manure	1.09	.....	.83	.75	5.67	.....	7.26	6.0	9.92	.....	10.16	1.0
Bradley's Complete Manure for Potatoes and Vegetables	3.78	3.75	*3.55	3.73	8.66	8.57	*8.14	8.0	6.06	6.24	*6.35	6.0
Bradley's Complete Manure for Top Dressing Grass and Grain	.....	4.78	4.91	4.95	.....	6.00	5.83	5.0	.....	3.02	2.84	2.5
Bradley's Corn Phosphate	2.16	.....	*2.03	2.05	9.18	.....	*8.93	9.0	2.01	.....	*1.59	1.5
Bradley's Eclipse Phosphate for all Crops	.....	.....	1.61	1.00	.....	.....	9.40	10.0	.....	.....	1.68	1.5
Bradley's Eureka Fertilizer	1.92	1.85	1.65	1.65	8.52	5.27	5.03	5.0	3.46	2.52	2.49	2.0
Bradley's Niagara Phosphate	.....	.....	1.25	1.00	.....	.....	7.68	7.0	.....	.....	1.18	1.1
Bradley's Potato Fertilizer	2.08	2.20	*2.12	2.06	9.71	9.00	*9.64	9.0	3.02	3.07	*3.03	†3.3
Bradley's Potato Manure	2.94	3.21	*2.66	2.50	5.89	6.09	*6.52	6.0	5.98	5.56	*5.59	5.0
Bradley's X L Phosphate	2.64	2.53	*2.47	2.50	9.89	10.37	*9.81	9.0	2.34	2.43	*2.34	2.0
Chittenden's Ammoniated Bone Superphosphate	1.55	2.08	2.04	1.07	9.83	10.21	9.47	†8.0	2.15	2.84	2.26	2.0
Chittenden's Complete Fertilizer	3.04	3.60	3.43	†3.03	9.30	8.95	8.52	8.0	5.32	6.67	6.47	6.0
Chittenden's Market Garden Fertilizer	2.43	2.33	2.39	†2.04	7.42	8.56	7.72	7.0	4.85	6.13	6.38	6.0
Cleveland Bone and Potash	.....	.....	.....	.....	.....	.....	10.23	6.0	.....	.....	3.02	2.5
Cleveland Fertilizer for All Crops	1.30	1.14	1.15	†1.03	7.72	8.35	8.98	8.0	2.07	2.02	2.22	2.0
Cleveland Pioneer Fertilizer	.....	.87	1.07	.82	.....	7.55	7.98	7.0	.....	1.47	1.70	1.0
Cleveland Potato Phosphate	2.19	2.05	*2.00	2.05	9.39	9.96	*9.00	8.0	3.18	3.08	*3.03	3.0
Cleveland Seeding Down Fertilizer	1.96	2.34	*1.48	1.65	8.37	8.24	*8.85	5.0	2.30	1.95	*2.17	2.0
Cleveland Superphosphate	2.33	2.16	2.13	2.05	8.71	8.86	9.17	9.0	2.05	2.06	2.46	2.0
Crocker's Ammoniated Bone Superphosphate	.....	.....	2.93	2.87	.....	.....	10.19	10.0	.....	.....	1.37	1.1
Crocker's Ammoniated Corn Phosphate	2.38	.....	1.92	2.05	10.04	.....	10.26	10.0	1.83	.....	1.67	1.6
Crocker's New Rival Ammoniated Superphosphate	1.46	2.21	1.24	1.23	10.46	9.93	9.94	10.0	1.92	2.00	1.84	†1.6
Crocker's Potato, Hop and Tobacco Phosphate	2.24	2.15	2.12	2.05	10.25	11.00	10.00	10.0	3.68	3.63	3.36	3.2
Crocker's Superior Fertilizer	.....	1.06	.82	.82	.....	9.12	8.22	8.0	.....	2.23	1.93	2.0
Cumberland Bone and Potash	.....	.....	.....	.....	.....	.....	10.01	8.0	.....	.....	2.95	2.5
Cumberland Potato Fertilizer	2.20	2.33	*1.84	2.06	9.62	9.19	*9.28	9.0	3.02	3.26	*2.56	3.0
Cumberland Seeding Down Manure	1.45	1.17	1.14	†1.03	7.78	8.87	9.12	8.0	2.31	2.28	2.44	2.0
Cumberland Superphosphate	2.23	2.18	2.07	2.06	9.08	9.58	8.74	8.0	1.96	2.22	2.05	2.0
Darling's Animal Fertilizer "G" Brand	.....	2.57	2.99	2.06	.....	7.92	7.88	†6.0	.....	4.94	4.20	4.0
Darling's Blood, Bone and Potash	.....	4.08	*3.82	†4.12	.....	8.18	8.39	*7.0	.....	9.55	*7.55	7.0

* Average of two analyses. † Guarantee changed in 1898. ‡ Total.

COMPARISON OF GUARANTEES AND STATION SAMPLES FOR 3 YEARS—CONTINUED.

Name of Fertilizer.	Nitrogen.				Available Phosphoric Acid.				Potash.			
	Found.			Guaranteed.	Found.			Guaranteed.	Found.			Guaranteed.
	1896.	1897.	1898.		1896.	1897.	1898.		1896.	1897.	1898.	
	%	%	%	%	%	%	%	%	%	%	%	%
Darling's Complete Maine Brand for Potatoes, etc.	.....	.....	2.38	3.20	.....	.....	8.57	8.0	.....	.....	12.07	12.0
Dirigo Fertilizer	1.69	3.40	1.71	2.00	7.42	6.52	4.77	†3.0	4.12	4.34	5.77	†4.0
E. Frank Coe's Bay State Ammoniated Bone Superphosphate	.....	1.91	2.30	2.0	.....	9.51	9.45	9.0	.....	1.92	2.31	1.85
E. Frank Coe's Bay State Imperial Superphosphate	.....	1.47	1.63	1.20	.....	10.11	9.47	9.0	.....	1.90	2.13	1.85
E. Frank Coe's Columbian Brand	.....	1.42	1.56	1.20	.....	10.52	9.20	9.0	.....	2.09	2.16	1.9
E. Frank Coe's Columbian Corn Fertilizer	.....	1.36	1.52	†1.00	.....	9.42	10.13	9.0	.....	1.99	2.27	†1.9
E. Frank Coe's Columbian Potato Fertilizer	1.50	1.42	1.51	†1.00	8.58	10.50	9.80	9.0	2.15	1.91	2.11	†1.9
E. Frank Coe's Excelsior Potato Fertilizer	.....	.....	2.46	2.50	.....	.....	7.72	8.0	.....	....	8.08	8.0
E. Frank Coe's Gold Brand Excelsior Guano	.....	2.16	2.66	2.50	.....	8.73	7.00	8.0	.....	5.43	5.15	6.0
E. Frank Coe's Grass and Grain Fertilizer	1.11	.....	1.07	8.0	9.18	.....	9.14	9.0	1.36	.....	1.70	1.4
E. Frank Coe's High Grade Ammoniated Superphosphate	.....	2.05	2.15	2.0	....	9.71	9.06	9.0	.....	2.48	2.41	†2.0
E. Frank Coe's High Grade Potato Fertilizer	2.47	2.65	*2.60	†2.40	8.13	8.85	*8.84	†7.0	6.34	5.79	*6.12	†6.5
E. Frank Coe's Original Ammoniated Dissolved Bone Superphosphate	.....	.....	1.42	1.25	.....	.....	9.88	10.0	.....	.....	2.84	2.25
E. Frank Coe's Prize Brand Grain and Grass Fertilizer	.....	.90	.66	†.40	.....	10.82	11.32	10.5	.....	1.43	1.37	†1.3
E. Frank Coe's Red Brand Excelsior Guano for Market Gardening	.....	.....	*3.16	3.50	.....	.....	*8.86	9.0	.....	.....	*6.55	6.0
E. Frank Coe's Seeding Down and Top Dressing Fertilizer	.2	....	.25	.....	11.77	11.00	11.04	12.0	1.89	2.62	2.49	2.75
E. Frank Coe's Special Potato Fertilizer	1.84	1.70	1.73	1.65	10.96	9.42	8.12	†8.0	3.34	3.84	4.23	†4.0
E. Frank Coe's Standard Grade Ammoniated Bone Superphosphate	1.90	1.71	1.90	1.75	8.97	10.13	9.93	8.0	1.46	1.78	1.82	†1.4
Essex Complete Manure for Corn, Grain and Grass	4.02	4.03	3.82	3.70	7.30	7.61	8.71	†7.0	10.80	11.04	9.78	9.5
Essex Complete Manure for Potatoes, Roots and Vegetables	3.47	4.55	4.12	3.70	6.98	8.08	7.52	7.0	10.03	9.46	9.39	9.5
Essex Dry Ground Fish	.....	.....	7.31	8.13	.....	.....	7.16	.....	.....	.....	.....	.....

Essex High Grade Superphosphate	2.90	2.89	2.57	2.50	9.86	8.61	9.80	9.0	5.91	4.25	5.15	4.0
Essex Odorless Lawn Dressing	.....	4.07	3.68	4.0	.....	4.32	3.19	5.5	.....	7.75	8.45	7.0
Essex Special Cauliflower and Cabbage Manure	.....	.....	4.72	4.99	.....	.....	8.07	7.5	.....	.....	7.95	7.0
Essex XXX Fish and Potash	2.05	2.20	2.46	2.10	8.88	9.97	9.66	†9.0	2.24	2.58	2.18	†2.3
Farrar's Potato Manure	3.00	3.55	*3.85	†2.25	11.36	12.22	*9.60	†9.0	2.01	2.80	*2.77	3.0
Farrar's Superphosphate	2.86	3.44	3.42	†2.50	11.37	13.46	9.74	†9.0	1.71	2.10	2.89	2.0
Foster's Vegetable and Vine	1.73	1.87	1.77	†1.65	6.68	6.57	6.32	6.0	8.42	8.32	7.54	8.0
Gloucester Fish and Potash	.....	1.06	1.12	.75	.....	10.60	9.42	6.0	.....	1.20	1.29	1.0
Great Eastern Dissolved Bone	.....	.....	.....	.....	.....	15.96	15.59	14.0	.....	.....	.36	.....
Great Eastern General Fertilizer	1.31	.94	1.19	.82	8.26	11.18	8.66	8.0	4.46	4.11	4.28	4.0
Great Eastern Grass and Oats Phosphate	.....	.....	.....	.....	12.97	13.63	12.59	11.0	1.97	2.37	2.07	2.0
Great Eastern Northern Corn Special	.....	3.04	*2.99	2.88	.....	8.48	*8.41	8.0	.....	2.13	*2.46	2.0
Great Eastern Potato Manure	2.11	2.03	2.35	†2.06	9.27	9.71	8.61	8.0	4.19	4.0	4.41	4.0
King Philip Alkaline Guano for Potatoes	1.38	1.56	1.40	1.23	7.34	6.99	7.59	6.5	3.15	3.28	3.18	3.0
Lister's Seeding Down Fertilizer	.....	1.64	1.47	1.32	.....	8.51	7.49	7.0	.....	2.72	2.39	2.0
Lister's Special Potato Fertilizer	1.86	1.61	1.78	1.65	8.84	9.79	8.68	8.0	3.25	3.76	3.17	3.0
Lister's Success Fertilizer	1.58	1.54	1.34	1.24	10.63	10.49	10.34	9.5	1.97	2.46	2.20	2.0
Maine State Grange Chemicals	.....	2.52	*2.54	2.50	.....	9.19	*8.23	8.0	.....	4.93	*4.23	4.0
Maine State Grange Potato Manure	.....	1.79	1.47	1.50	.....	9.15	9.83	9.0	.....	12.24	11.27	12.0
Maine State Grange Seeding Down Fertilizer	.....	1.71	1.65	1.50	.....	9.23	6.10	7.0	.....	6.66	5.59	5.5
Nash's Pure Bone Meal	2.26	2.65	1.66	†3.00	‡24.66	‡20.56	‡27.68	‡18.0	.....	.....	.....	.....
Nobsque Guano	1.18	1.25	*1.18	1.15	9.29	8.06	*8.58	†8.0	1.87	2.00	*2.18	2.0
Otis Potato Fertilizer	2.14	2.09	2.33	2.0	9.59	9.44	9.45	9.0	3.47	3.26	2.31	3.0
Otis Seeding Down Fertilizer	.....	1.02	1.43	1.50	.....	8.44	9.36	†8.0	.....	2.29	2.19	†2.0
Otis Superphosphate	.....	2.62	1.76	2.0	.....	9.22	9.23	9.5	.....	2.46	3.06	2.0
Pacific Guano Company Dissolved Bone and Potash	.....	.....	.....	.....	.....	.....	10.23	10.0	.....	.....	2.33	2.0
Pacific Guano Company Grass and Grain Fertilizer	1.19	1.18	1.06	.82	9.44	8.50	9.44	7.0	1.93	2.06	1.80	.....
Pacific Guano Company Potato Special	.....	2.18	*1.98	†2.05	.....	8.70	*9.05	8.0	.....	3.36	*3.0	3.0
Packer's Union High Grade Animal Corn Fertilizer	.....	2.92	*2.45	2.47	.....	9.15	*7.67	8.0	.....	2.71	*2.19	2.0
Packer's Union High Grade Potato Manure	.....	2.00	2.06	2.06	.....	7.05	8.45	8.0	.....	5.03	6.15	6.0
Packer's Union High Grade Wheat, Oats, and Clover Fertilizer	.....	.....	.....	.....	.....	10.73	11.37	11.0	.....	2.22	2.13	2.0
Philbrick's Fertilizer	.....	.....	1.96	2.0	.....	.....	7.58	7.0	.....	.....	4.83	5.0
Portland Rendering Company's Tankage	.....	4.42	5.18	†4.42	.....	8.06	8.98	†8.1	.....	.....	.....	.....

* Average of two analyses. † Guarantee changed in 1898. ‡ Total.

COMPARISON OF GUARANTEES AND STATION SAMPLES FOR 3 YEARS—CONCLUDED.

Name of Fertilizer.	Nitrogen. Found. 1896.	Nitrogen. Found. 1897.	Nitrogen. Found. 1898.	Nitrogen. Guaranteed.	Available Phosphoric Acid. Found. 1896.	Available Phosphoric Acid. Found. 1897.	Available Phosphoric Acid. Found. 1898.	Available Phosphoric Acid. Guaranteed.	Potash. Found. 1896.	Potash. Found. 1897.	Potash. Found. 1898.	Potash. Guaranteed.
	%	%	%	%	%	%	%	%	%	%	%	%
Quinnipiac Climax Phosphate	......	1.37	1.12	1.03	......	8.84	8.39	8.0	......	1.72	2.29	2.0
Quinnipiac Dissolved Bone and Potash	......	......	......	......	......	......	10.32	10.0	......	......	2.46	2.0
Quinnipiac Corn Manure	......	2.37	2.16	2.06	......	10.25	9.29	9.0	......	1.43	1.91	1.5
Quinnipiac Mohawk Fertilizer	......	.78	.83	.82	......	8.66	8.27	7.0	......	1.46	1.49	1.0
Quinnipiac Phosphate	2.38	2.51	*2.53	2.47	9.18	9.11	†9.12	9.0	2.08	2.22	†2.12	2.0
Quinnipiac Potato Manure	2.74	2.59	*2.45	2.47	7.89	8.53	†8.10	6.0	6.00	4.78	†4.37	5.0
Quinnipiac Potato Phosphate	2.06	2.10	2.01	2.05	9.29	9.01	9.17	8.0	2.89	2.82	2.90	3.0
Quinnipiac Seeding Down Manure	1.21	2.17	1.02	.82	8.44	8.37	9.35	9.0	2.10	2.78	2.31	2.0
Read's Practical Potato Special	1.05	.93	1.05	.82	4.83	4.91	4.65	4.0	7.66	8.40	8.36	8.0
Read's Standard	1.14	1.04	1.01	.82	8.38	8.45	8.24	8.0	3.94	4.52	4.04	4.0
Read's Sure Catch	......	......	......	......	5.92	6.98	*6.29	6.0	3.59	4.27	*3.62	4.0
Royal Bone Phosphate	1.22	1.24	1.05	1.03	9.39	8.62	9.20	7.0	2.06	2.16	2.22	2.0
Sagadahoc Low Price Brand	......	......	.72	1.50	......	......	9.84	3.0	......	......	2.38	1.5
Sagadahoc Merrymeeting Brand	......	......	1.57	1.50	......	......	7.15	5.0	......	......	2.81	2.0
Sagadahoc Special Potato Fertilizer	2.21	1.89	2.14	†2.75	7.14	7.09	6.96	†6.0	7.05	8.18	7.60	†7.0
Sagadahoc Superphosphate	......	2.47	1.52	†2.50	......	9.01	7.49	†6.0	......	3.80	4.86	†4.0
Sampson Fertilizer	......	......	2.72	1.65	......	......	7.79	6.0	......	......	5.66	4.0
Sea Fowl Guano	......	2.34	1.97	2.06	......	8.36	8.62	8.0	......	1.63	1.94	1.5
Soluble Pacific Guano	2.26	2.84	2.33	2.25	9.25	9.56	8:61	8.5	2.11	2.35	2.28	2.0
Standard A Brand	1.28	1.10	1.07	.82	8.79	8.71	8.87	7.0	2.01	2.02	2.41	1.0
Standard Bone and Potash	......	......	......	......	......	......	10.04	8.0	......	......	2.20	2.5

Standard Fertilizer	2.23	2.07	2.17	2.0	6.34	9.51	8.94	8.0	3.14	2.28	2.40	2.0
Standard Guano	1.52	1.36	1.30	1.25	7.84	7.15	7.74	6.5	3.29	3.51	3.06	3.0
Standard Special for Potatoes	......	2.14	2.20	2.05	......	9.09	8.96	8.0	......	3.14	3.08	3.0
Stockbridge Corn and Grain Manure	3.54	3.60	*2.67	3.0	9.47	7.37	*9.31	8.0	4.72	7.11	*7.41	†6.0
Stockbridge Pea and Bean Manure	2.93	2.53	2.27	2.0	7.48	5.74	7.70	6.0	10.04	11.08	9.95	6.0
Stockbridge Potato and Vegetable Manure	2.34	2.96	3.28	3.25	6.11	7.09	6.90	6.0	11.83	10.98	10.06	10.0
Stockbridge Seeding Down Manure	2.55	2.68	2.12	2.50	11.68	6.29	7.48	6.0	9.49	10.46	10.77	10.0
Stockbridge Strawberry Manure	......	2.26	2.40	2.25	......	8.62	9.03	6.0	......	5.21	4.32	4.0
Stockbridge Top Dressing Manure	4.21	......	4.47	5.0	5.50	......	5.93	4.0	4.83	......	6.31	6.0
Swift's Lowell Animal Fertilizer	2.78	2.44	2.54	2.46	13.35	10.50	9.52	†9.0	3.96	4.85	4.41	4.0
Swift's Lowell Bone Fertilizer	2.64	1.38	1.88	1.64	7.36	7.72	8.06	†8.0	4.0	3.22	3.42	3.0
Swift's Lowell Dissolved Bone and Potash	2.79	1.49	1.86	1.64	11.74	7.76	9.29	†9.0	2.48	2.47	2.07	2.0
Swift's Lowell Fruit and Vine Fertilizer	3.48	2.89	3.48	†3.28	12.36	10.64	7.38	†7.0	3.55	7.55	6.19	6.0
Swift's Lowell Ground Bone	......	......	2.26	2.46	......	......	‡27.96	‡23.0	......	......	......	......
Swift's Lowell Market Garden Manure	......	......	4.16	4.10	......	......	8.20	7.0	......	......	5.92	6.0
Swift's Lowell Potato Phosphate	3.29	2.79	2.68	†2.46	12.76	9.07	9.01	†8.0	3.56	5.78	5.97	6.0
Thompson & Edward's Pure Fine Ground Bone	......	1.91	2.74	2.47	......	‡16.00	‡18.16	....	......	......	......	......
Triumph Bone and Potash	......	......	......	......	......	......	9.87	10.0	......	......	3.57	2.0
Tucker's Original Bay State Bone Superphosphate	......	2.19	2.07	2.06	......	9.58	11.44	9.0	......	2.09	2.12	2.0
Williams and Clark's Dissolved Bone and Potash	......	......	......	......	......	......	10.41	10.0	......	......	2.34	2.0
Williams and Clark's Potato Phosphate	2.97	2.56	*2.42	2.47	7.91	8.24	*8.26	6.0	5.88	4.88	*4.26	5.0
Young's Excelsior Potato Fertilizer	......	......	2.80	2.88	......	......	6.59	5.5	......	......	9.94	10.0

* Average of two analyses. † Guarantee changed in 1898. ‡ Total.

FEEDING STUFF INSPECTION.

The legislature of 1897 passed a law entitled "An Act to regulate the sale and analysis of Concentrated Commercial Feeding Stuffs." In essence the law, which is very similar to the law regulating the sale of commercial fertilizers, went into effect October 1, 1897, and is the first attempt to establish an adequate control over the sale of offals and other by-products used as food for cattle, and other live stock.

Chief Provisions of the Law.

The full text of the law will be sent on application. The points of the law of most interest, both to the dealer and consumer, are concisely stated below.

Kinds of Feed coming within the Law. The law covers all feeding stuffs *except* hays and straws; whole seeds and meals of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn; brans and middlings. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chops, ground beef or fish scraps, mixed feeds, and all other materials of similar nature.

The Brand. Each package of feeding stuff included within the law shall have affixed the inspection tax tag, and shall also bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of crude protein.

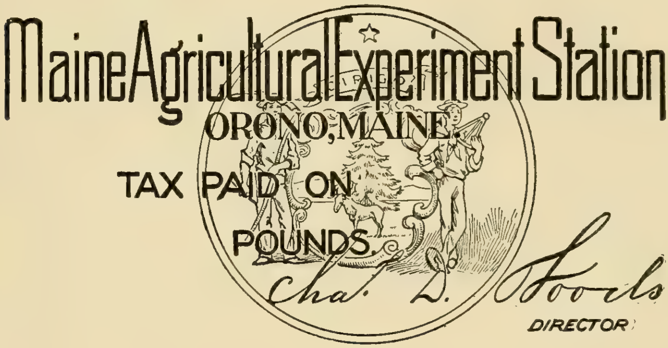
The percentage of crude fat.

These statements *which constitute the guarantee* may be printed directly on the bag, on a tag to be attached to the package, or on the back of the inspection tax tag furnished by the Director of the Station.

A certified copy of this statement of brand must be filed with the Director of the Station.

Inspection Tax. In order to meet the expenses of inspection, a tax of ten cents per ton must be paid to the Director of the Maine Agricultural Experiment Station.

Inspection Tax Tag. The Director of the Station, on receipt of the inspection tax, is required to furnish a tag stating that all charges have been paid. The inspection tax tag now in use consists of an ordinary shipping tag, colored red, similar in design to the following:



These tags, with the number of pounds printed in, will be furnished in any quantity on receipt of the tonnage tax. The tags will be provided with "dead lock fasteners" if desired. Unused tags will be redeemed at any time. Tags will be sent by express, charges for carriage to be collected.

The inspection tag is not a guarantee. It merely shows that the tax has been paid on the package to which it is attached.

Analysis. Whenever the Director of the Station requests, the certificate must be accompanied by a sealed sample of the goods so certified. It also is the duty of the Director to collect each year at least one sample of each of the brands of feeding stuffs coming within the provisions of this act. These samples are to be analyzed and the results, together with related matter, published from time to time in the form of bulletins.

Analyses for manufacturers, dealers and others, which are not of general interest and which are not called for by the provisions of the act, will be made on request at a price sufficient to cover the cost of analysis. The rates will be: for protein, one dollar; for fat, two dollars. Under no conditions will the Station undertake analyses the results of which cannot be published.

Inspectors.

The following gentlemen have acceptably served the Station as inspectors during 1898.

Arthur B. Briggs, Hartford; J. W. Dudley, Castle Hill; F. B. Elliot, Bowdoinham; A. S. Farnsworth, West Pembroke; W. G. Hunton, Readfield; Ora W. Knight, Bangor; W. H. Snow, Milo; L. O. Straw, Newfield; P. C. Wentworth, East Hiram; Chas. E. Wheeler, Chesterville; John M. Winslow, Glendon.

The inspectors visited the large dealers in their territory three times during the year, in the month of January, March and November. At least one sample of each kind of feeding stuff coming under the law was taken by each inspector. The results of the analyses were printed as bulletins 44 and 48.* The more important of the figures are here summarized. The discussions are largely taken from the bulletins.

*Bulletin 48 was not distributed until January, 1899.

SUMMARY OF ANALYSES, WINTER 1898.

Kind of Feeding Stuff.	Number of analyses.		PROTEIN. Found—per cent.	PROTEIN. Guaranteed—per cent.	FAT. Found—per cent.	FAT. Guaranteed—per cent.
American Cotton Oil Co.'s		Highest.	50.75	....	16.96	
Prime Cotton Seed Meal......	15	Lowest.	43.12	43.00	8.83	9.00
		Average	46.23	....	12.43	
Southern Cotton Oil Co.'s		Highest.	48.25	....	13.10	
Prime Cotton Seed Meal	14	Lowest.	43.63	43.00	9.39	9.00
		Average	46.29	....	11.07	
F. W. Brodé & Co.'s		Highest.	50.63	....	14.08	
Owl Brand Cotton Seed Meal.	6	Lowest.	43.56	43.00	9.39	9.00
		Average	47.39	....	11.29	
S. W. Thaxter & Co.'s		Highest.	52.63	....	12.04	
Cotton Seed Meal	2	Lowest.	51.25	49.25	11.78	15.62
		Average	51.94	....	11.91	
J. E. Soper & Co.'s		Highest.	49.19	....	12.74	
Cotton Seed Meal..............	2	Lowest.	47.25	43.00	9.81	9.00
		Average	48.22	....	11.28	
Cleveland Linseed Oil Co.'s		Highest.	37.25	....	3.35	
Linseed Oil Meal..............	4	Lowest.	34.63	39.00	1.99	1.50
		Average	36.46	....	2.53	
Cleveland Linseed Oil Co.'s						
Cleveland Flax Meal..........	1	....	41.00	39.00	3.47	1.50
S. A. & J. H. True Co.'s		Highest.	37.13	....	6.84	
Linseed Oil Meal...	2	Lowest.	34.81	36.94	6.32	6.58
		Average	35.87	....	6.58	
Chas. Pope Glucose Co.'s		Highest.	41.31	....	4.41	
Cream Gluten Meal	7	Lowest.	32.06	37.12	2.69	3.20
		Average	34.55	....	3.79	
National Starch Man'fg Co.'s		Highest.	33.75	....	18.37	
King Gluten Meal	5	Lowest.	26.38	34.26	14.60	14.65
		Average	31.49	....	16.66	
The Glucose Sugar Refin'g Co.'s		Highest.	38.38	....	4.15	
Chicago Gluten Meal.........	15	Lowest.	34.00	37.50	2.48	9.00
		Average	35.64	....	3.37	
American Glucose Co.'s		Highest.	29.56	....	4.74	
Buffalo Gluten Feed...........	3	Lowest.	28.69	29.90	3.91	3.38
		Average	29.29	....	4.44	
		Highest.	24.87	....	4.66	
Climax Gluten Feed	2	Lowest.	23.94	24.10	3.07	6.18
		Average	24.41	....	3.86	
Rockford Sugar Refining Co.'s		Highest.	30.06	....	3.74	
Diamond Gluten Feed	6	Lowest.	21.38	24.20	2.84	3.76
		Average	24.01	.. ..	3.17	
The H-O Co.'s		Highest.	13.81	....	4.40	
Horse Feed	3	Lowest.	13.06	12.30	4.15	4.90
		Average	13.52	....	4.25	
The H-O Co.'s						
Poultry Feed	1	....	19.50	16.80	5.62	7.00

SUMMARY OF ANALYSES, WINTER 1898—CONCLUDED.

Kind of Feeding Stuff.	Number of analyses.		Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.
The H-O Co.'s Dairy Feed	2	Highest.	21.19	....	4.71	
		Lowest.	21.19	18.75	4.57	7.25
		Average	21.19	....	4.64	
American Cereal Co.'s Victor Corn and Oat Feed	6	Highest.	10.69	....	4.87	
		Lowest.	8.63	8.21	3.30	3.15
		Average	9.36	....	3.79	
American Cereal Co.'s Quaker Oat Feed	6	Highest.	12.82	....	4.14	
		Lowest.	7.94	12.03	2.82	3.49
		Average	10.51	....	3.29	
W. H. Haskell & Co.'s Haskell's Oat Feed............	1	....	10.56	9.62	7.43	7.66
Chas. M. Cox & Co.'s Oatena........................	1	....	9.38	10.00	4.25	4.00
Bowker Fertilizer Co.'s Bowker's Animal Meal	2	Highest.	41.38	....	12.12	
		Lowest.	39.38	30.00	10.60	5.00
		Average	40.35	....	11.36	
Bradley Fertilizer Co.'s Bradley's Superior Meat Meal	2	Highest.	44.50	....	17.22	
		Lowest.	43.56	40.00	17.02	15.00
		Average	44.03	....	17.12	
Nash Manufacturing Co.'s Nash's Beef Scraps............	1	....	47.69	52.19	30.26	28.42
Frank S. Farrar & Co.'s Farrar's Meat Scrap	1	....	50.63	42.00	25.20	30.00

SUMMARY OF ANALYSES, FALL 1898.

Kind of Feeding Stuff.	Number of analyses.		Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.
American Cotton Oil Co.'s Prime Cotton Seed Meal......	14	Highest.	47.81	....	13.32	
		Lowest.	42.25	43.00	8.80	9.00
		Average	45.71	....	10.75	
Southern Cotton Oil Co.'s Prime Cotton Seed Meal......	1	....	46.82	43.00	9.76	9.00
J. E. Soper & Co.'s Cotton Seed Meal..............	2	Highest.	46.13	....	14.72	
		Lowest.	44.75	43.00	8.78	9.00
		Average	45.44	....	11.75	
R. B. Brown Oil Co.'s Prime Cotton Seed Meal......	2	Highest.	47.88	....	9.97	
		Lowest.	46.75	43.00	8.34	9.00
		Average	47.32	....	9.16	
S. W. Thaxter & Co.'s Cotton Seed Meal.........	4	Highest.	51.92	....	11.25	
		Lowest.	48.69	49.25	10.33	15.62
		Average	50.48	....	10.79	
F. W. Brodé & Co.'s Owl Brand Cotton Seed Meal.	10	Highest.	46.38	....	13.13	
		Lowest.	43.31	43.00	9.90	9.00
		Average	44.68	....	11.90	

SUMMARY OF ANALYSES, FALL 1898—CONTINUED.

Kind of Feeding Stuff.	Number of analyses.		Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.
Sea Island Cotton Seed Meal ...	2	Highest.	25.06	24.31	7.09	5.00
		Lowest.	21.82	20.13	5.83	4.57
		Average	23.44	....	6.46	
Charles Pope Glucose Co.'s Cream Gluten Meal	7	Highest.	35.69	....	5.43	
		Lowest.	30.94	37.12	2.24	3.20
		Average	33.22	....	3.53	
The Glucose Sugar Refin'g Co.'s Chicago Gluten Meal..........	14	Highest.	40.63	38.00	2.79	3.37
		Lowest.	36.13	36.00	1.70	2.00
		Average	38.01	....	2.15	
National Starch Man'fg Co.'s King Gluten Meal......	11	Highest.	37.32	....	16.40	
		Lowest.	31.50	32.00	4.28	16.00
		Average	33.62	....	11.72	
Arthur R. Hopkin's Imperial Gluten Meal.........	1	....	20.13	20.00	12.00	11.50
American Glucose Co.'s Buffalo Gluten Feed	1	....	28.25	29.00	4.68	3.00
S. W. Thaxter & Co.'s Gluten Feed	1	....	22.63	.. ..	5.93	.....
The Glucose Sugar Refin'g Co.'s Rockford Diamond Glut. Feed	4	Highest.	25.75	....	4.43	
		Lowest.	24.69	24.20	3.44	3.75
		Average	25.33	....	3.95	
Douglas & Co.'s Old Process Oil Meal	1	....	26.63	36.94	6.45	6.58
Cleveland Linseed Oil Co.'s Cleveland Flax Meal..........	1	.. ..	39.75	39.00	2.28	1.50
Cleveland Linseed Oil Co.'s Linseed Oil Meal..............	1	....	36.81	39.00	2.52	1.50
The American Cereal Co.'s Victor Corn and Oat Feed	11	Highest.	9.94	....	4.92	
		Lowest.	8.12	9.46	2.85	3.92
		Average	9.06	....	3.83	
S. A. & J. H. True Co.'s Corn and Oat Feed	1	....	8.38	9.63	3.44	4.23
The American Cereal Co.'s Quaker Oat Feed	9	Highest.	11.13	....	3.97	
		Lowest.	7.44	12.03	2.57	3.49
		Average	8.96	....	2.96	
The American Cereal Co.'s American Poultry Food	1	....	14.19	.. ..	5.91	......
The American Cereal Co.'s Corn, Oat and Barley Feed ...	1	....	12.75	11.26	5.39	4.15
W. H. Haskell & Co.'s Haskell's Oat Feed...........	1	....	11.31	9.62	7.91	7.66
Andrew Cullen & Co.'s Crescent Oat Feed.......	1	....	8.63	....	3.72	. ....
Monarch Oat Feed	1	... .	11.19	10.25	8.79	7.47

SUMMARY OF ANALYSES, FALL 1898—CONCLUDED.

Kind of Feeding Stuff.	Number of analyses.		Protein. Found—per cent.	Protein. Guaranteed—per cent.	Fat. Found—per cent.	Fat. Guaranteed—per cent.
The H-O Co.'s Poultry Feed	3	Highest.	18.31	....	5.92	
		Lowest.	17.81	16.80	5.43	7.00
		Average	18.04	....	5.70	
The H-O Co.'s Standard Dairy Feed	3	Highest.	20.94	....	5.42	
		Lowest.	17.06	18.75	4.24	7.25
		Average	19.46	....	5.02	
The H-O Co.'s Horse Feed	3	Highest.	11.94	....	4.75	
		Lowest.	11.69	12.30	3.81	4.90
		Average	11.81	....	4.36	
E. W. Blatchford's Calf Meal	1	....	33.44	....	5.23	......
Bowker Fertilizer Co.'s Bowker's Animal Meal	5	Highest.	44.94	....	14.05	
		Lowest.	40.50	30.00	12.05	5.00
		Average	42.51	....	12.95	
Bradley Fertilizer Co.'s Superior Meat Meal	1	....	43.56	40.00	15.95	15.00
Bradley Fertilizer Co.'s Old Fashioned Beef Scraps	1	....	49.13	40.00	19.60	10.00

The figures of the tables explain themselves and little comment is needed. The following brief statements contain, however, some facts not included in the tabular matter, and will help to a better understanding of the workings of the law.

Cottonseed Meal.

Pure cottonseed meal is made by grinding the seed after the white down, which remains upon the seed as it comes from the cotton gin, and the hard hulls have been removed. Thus prepared, cottonseed meal carries from 40 to 53 per cent of protein. At first cottonseed meal was all high grade goods. The temptation to adulterate was too strong for unscrupulous manufacturers to withstand and the market was overrun with cottonseed meal adulterated with finely ground hulls. This made a dark colored meal, the color of which was sometimes "improved" by grinding and mixing a bright yellow clay with the meal. Some of these meals were known in the trade as "Sea Island" cottonseed meal, and others were sold without

any brand. The following analyses show how these inferior and adulterated goods run.

ANALYSES OF ADULTERATED COTTON SEED MEALS.

Number.	Protein—per cent.	Fat—per cent.	Number.	Protein—per cent.	Fat—per cent.
8006	26.00	5.63	8022	26.25	....
8009	29.94	6.78	8025	34.00	8.36
8010	26.19	7.14	8028	20.13	4.57
8015	22.00	9.60	8043	21.19	5.88
8016	29.75	10.59	8048	26.94	....
8018	25.63	....	8062	25.13	....

Goods of this type were very abundant in this State in 1897, but there are almost none of them to be found at present. In the spring of 1898 the inspectors reported a few lots of these goods. In November, 1898, only two lots of low grade cottonseed meal were found by the inspectors, and these samples were guaranteed in accordance with their low grade. It would seem as though the inspection law has driven them to other states. The chemist of the Rhode Island Station under date of March 10, 1898, wrote inquiring regarding the working of the law and said, "I regret to say that Rhode Island is becoming the dumping ground of adulterated cottonseed meal, et cetera." This is also indicated by the following received from a large manufacturer of cottonseed meal. "You will please print tags as ordered for x x x x Mill and send same by freight instead of express. We have discovered that the meal we anticipated shipping into Maine market was not of sufficient quality to meet requirements of your State. We have, therefore, concluded not to ship as anticipated. We will, later in the season, have a very nice grade of meal at x x x x Mill at which time we will place same in Maine market."

Occasionally the Station has had sent to it by correspondents samples of suspected meal, but with one exception analyses have shown them to be up to guarantee. Not all dark colored meal is adulterated and not all bright yellow meal is free from adulteration.

The law has proven itself a decided advantage to the manufacturer and dealer in honest cottonseed meal, and is practically

prohibitive to adulterated goods. It is gratifying to note that in no case has the percentage of protein fallen materially below the guarantee. From the fact that much of the cottonseed meal carries more protein than the guarantee, it will probably result in grading the cottonseed meals according to their composition. One firm in the winter of 1898 handling unusually good cottonseed did this, guaranteeing the meal to carry 49 per cent protein, instead of the 43 per cent of the other brands.

Linseed Meal.

Linseed meal is made by grinding flaxseed from which the oil has been more or less completely extracted. "Old Process" contains more fat and somewhat less protein than "New Process" linseed meal.

True and Company based their guarantee upon an analysis made for them by the Station in October, 1897. Of the two samples collected, one was a little above, the other a little below, the guarantee. The goods were quite uniform, however.

The Cleveland Linseed Oil Company placed the same guarantee upon their oil meal as on their flax meal. The flax meal proved better and the oil meal poorer than the guarantee. The attention of the company has been called to this, and they will doubtless change their guarantee of protein in the oil meal.

Only three samples of linseed meal were found by the inspectors in November. Its high cost, relative to cottonseed meal had apparently crowded it out of the market. The guarantee of Douglass & Company's oil meal was based upon an analysis of a sample sent to the Station months before by the wholesaler, who writes as follows: "When you analyzed our oil meal we had a large quantity on hand, and we tagged as you directed. It is so high now that very little is sold and we have had a few lots that we have sold and we supposed was of same quality. We have not at present a single sack in our store."

Gluten Meals and Feeds.

Gluten meals and gluten feeds are by-products left in the manufacture of starch and glucose from Indian corn. Corn consists largely of starch. The waste product from the manufacture of starch or sugar is relatively much richer in oil and

protein than corn. Many factories are removing part of the corn oil from the waste, so that some gluten meals carry but little oil, e. g., Chicago Gluten Meal, which a few months ago carried 7 to 9 per cent of fat, now has from 2.50 to 4 per cent. This reduction in fat is probably an advantage, as feeding corn oil to dairy animals seems to have a tendency to make the butter soft.

No by-products used for feeding differ more from each other than do these starch and sugar wastes. The manufacturers apparently do not recognize that the composition of these offals change greatly, and some of them have based their guarantees upon old analyses.

Cream gluten meal is not up to the guarantee in protein. It is guaranteed to carry thirty-seven per cent, but from the samples drawn the purchaser can not expect more than thirty-three per cent of protein on the average, and one sample ran as low as thirty-one per cent of protein. The attention of the handlers of this feed has been called to these discrepancies between guarantee and analysis and they will probably be corrected on future shipments.

These samples of Chicago gluten meal represent both old and new goods. The old goods were guaranteed too high in fat. The present guarantee, thirty-eight per cent protein and two per cent fat, fairly well represents the goods on the market. The protein found in the samples examined, agrees as closely as can be expected with the guarantees. The State agents seem to be anxious that their guarantees shall represent the goods as sold.

King gluten meal as sold in Maine comes from two mills, the output of which differ greatly in composition. The goods made at the Des Moines mill are very close with the guarantee, thirty-two per cent protein and sixteen per cent fat; the goods from the Indianapolis mills are higher in protein than the guarantee and are correspondingly low in fat. The Indianapolis goods carry about thirty-four per cent protein and four per cent of fat. The attention of the dealers has been called to this and the goods will be correctly branded in the near future.

Feeds Low in Protein.

Very few farmers can afford to buy feeds low in protein and high in carbohydrates at any price at which they have been or are likely to be offered. The farmer should grow all the coarse feeds that he needs. Oat and similar feeds are very much like corn stalks or oat straw in composition. Some of the feeds have cottonseed or other nitrogenous feeding stuffs added to them so that they carry more protein than straight oat feeds, but these mixtures are always more expensive sources of protein than are the glutens, cottonseed and linseed meals. One hundred pounds of an ordinary oat feed has from eight to eleven pounds protein. At seventy-five cents per hundred the protein costs from seven to nine cents a pound. One hundred pounds of a good gluten meal has from thirty-four to forty per cent of protein. At $1.10 per hundred the protein costs about three cents a pound and it not only costs less than half as much but it is better digested. As a source of protein, it would be as good economy to pay $60.00 a ton for high grade cottonseed meal as to pay $15.00 a ton for the ordinary oat feed.

A number of samples of different oat feeds have been examined. For the most part guarantees are based upon single analyses of the feeds and the goods usually are not quite as good as the sample upon which the guarantee rests. With the exception of the American Cereal Company's Quaker Oat Feed none of these materials are much below and some run above the guarantee.

Blatchford's Calf Meal.

This is a manufactured food only one lot of which was found by our inspectors. This was not guaranteed but carried 33.44% protein and 5.23% of fat. In some advertising matter connected with Blatchford's calf meal it is claimed that 12.8 pounds of it has three and one-half pounds of protein which is about twenty-seven and one-half per cent. A sample of these goods sent by a dealer to the Station in September analyzed as follows:

Water, 7.70%; ash, 5.46%; protein, 25.63%; crude fiber, 5.28%; starch, 18.24%; undetermined carbohydrates, 32.13%; fat, 5.56%. It will be observed that the goods as evidenced by the official sample and this lot sent to the Station are very uneven

in composition;—one sample carrying about 26% and the other about 33% of protein. A large part of the ash is common salt.

These goods were sent to an expert on food mixtures and adulterations at the Connecticut Experiment Station who reports as follows: "I have examined Blatchford's calf meal under the microscope and find it contains linseed meal, some product from the wheat kernel, some product from the bean kernel and a little fenugreek. The linseed meal appears to be the chief constituent. The wheat product is bran, middlings or some similar product consisting of starchy matter mixed with more or less of the seed coats. Bean bran was present in considerable amount and more or less of the starchy matter."

In a letter, Mr. J. W. Barwell, the proprietor of these goods, said: "Regarding the ingredients, I cannot give you the exact constituents of it, but I may say that it is composed mostly of locust bean meal with leguminous seeds such as lentils, etc., and oleaginous seeds such as flaxseed, fenugreek and annis seed, all cleaned, hulled and ground together and thoroughly well cooked. There is no cheap mill food and no low grade feed enters into this composition. I am prepared to go into any court in the United States and make an affidavit that there is no farmer in the United States that can compound Blatchford's calf meal for less than $3.50 per hundred."

Locust bean meal which Mr. Barwell claims to be the chief constituent of Blatchford's calf meal is practically not used in this country as a cattle feed. The average of ten English and German analyses show it to carry:—water, 14.96%; ash, 2.53%; protein, 5.86%; crude fiber, 6.39%; nitrogen-free-extract, 68.98%; fat, 1.28%.

It is evident from the chemical analysis that locust bean meal cannot be the chief constituent of Blatchford's calf meal, but that the microscopist is correct that linseed meal is the chief constituent. Locust bean meal has only six per cent of protein and in order to make a mixture carrying from twenty-six to thirty-three per cent of protein, it would be necessary to add large quantities of goods like linseed meal rich in protein. As seen from the analysis Blatchford's calf meal has a feeding value somewhat inferior to old process linseed meal. Whatever it may cost to manufacture, no man who has sufficient intelli-

gence to mix feeds can afford to buy it at anything like the price ($70 per ton) asked.

The Operation of the Law.

It was and is the belief of the writer that all the principal manufacturers and dealers are reliable men, of strict integrity. The enforcement of the law has been made on this assumption, and we have enjoyed the coöperation of dealers and manufacturers, as well as that of consumers. No case of wilful violation has come to our notice. On the contrary there has been an evident desire on the part of most dealers to live up to all the requirements of the law.

The most noticeable thing accomplished by the law is the driving out of the State, the adulterated cottonseed meal which was so largely sold in 1897. The law has come into effect with little friction, and bids fair to run as smoothly and satisfactorily as the fertilizer law. It protects both the dealer and the consumer. It tends toward a more rational use of feeding stuffs, which will be alike beneficial to the feeder and the dealer.

Inspection of Chemical Glassware used in Creameries.

Nearly all the glassware that has been examined during the year has come from dealers in dairy supplies. It is reasonable to suppose, therefore, that the butter factories have renewed their stock by purchasing tested bottles and pipettes direct from the dealers and are complying with the law in that respect.

It has been gratifying to note that a very small percentage of the goods inspected the past year was inaccurately graduated. All bottles and pipettes examined by the Station and found correct have the letters M. E. S. etched upon them. The text of the law will be sent on application.

SEED TESTING.

The law passed by the legislature of 1897, while it imposes certain duties upon the Director of the Station, is not an inspection law. Bulletin 36, published in August, 1897, contains the law and rules for testing purity of seeds. Copies of this bulletin are still available and will be sent on application.

Since the enactment of a seed inspection law in Maine quite a number of samples have been received by the Station for exam-

ination. Five grams of all the seeds submitted (excepting red top of which only two grams were inspected) were examined. The inert matter and foreign seeds were separated by hand and then the foreign seeds classified into harmful and noxious. The inert matter and foreign seeds were weighed and the per cent calculated. The weed seeds were usually counted so as to give the number in a pound and the names of the weeds determined by comparison with sets of named seeds.

The inert matter consisted of sand, fragments of stems and leaves, chaff, whole insects, fragments of insects and insect excreta. The harmless foreign seed consisted mostly of red top and clover in timothy, timothy, red top and clover in alsike and timothy and clover in red top. There were several other species of grass seeds present some of which we were not able to determine. Some were noxious, some indifferent. We think most of the samples examined came from outside the State and were purchased to sell as seed. There were sixty-five kinds of weed seed detected, the most important of which are tabulated below.

The kinds and amount of weed seeds found in the samples examined lead to the belief that seed for planting is not the only source of weeds in the State. A good many of the weed seeds found in the samples would not grow. An examination of whole grain brought in by the car-load and distributed in the State shows that it frequently carries many weed seeds. Inter-state and State commerce where packing material is used are also important sources of weeds.

It will be noticed from the appended tables that the per cent of purity of seeds was for the most part high and that a large number of samples contained no weed seeds or only those that were not pernicious.

It is impossible to get a correct idea of the average per cent of purity of seed sold in the State from samples sent for examination, as one sample may represent only a few bags and another a car-load. A statement of the per cent of purity of a seed gives but little idea of its nature, as the impurities may be large and consist of harmless seeds or indifferent weeds, while one showing a low per cent of impurities may contain the vilest weed seeds.

The tables showing the results of the analyses of samples of seeds follow.

TABLE SHOWING THE RESULTS OF SEED ANALYSES INCLUDING PERCENTAGES OF PURITY, TOTAL IMPURITIES, INERT MATTER, FOREIGN AND WEED SEEDS.

	Number of samples examined.	Samples free from inert matter.	Samples free from foreign seed.	Samples free from weed seeds.	Highest per cent of purity.	Lowest per cent of purity.	Average per cent of purity.	Highest per cent of impurity.	Lowest per cent of impurity.	Average per cent of impurity.	Per cent of weed seeds.*	Per cent of inert matter.
Red Clover	45	4	4	4	100	92.2	98.6	7.8	.45	1.4	1.08	.33
White Clover	1	....	....	....	99.7	......	99.7	.3	.90	.3	.20	.10
Alsike	24	....	....	....	99.1	93.4	97.2	6.6	...	2.8	1.85	.58
Peavine Clover	1	....	....	....	98.8	......	98.8	1.2	....	1.2	1.00	.20
Timothy	51	2	....	9	99.9	96	99.2	4.0	.10	.8	.46	.40
Redtop	7	....	....	2	99.5	21.6	85.7	78.4	.55	4.3	4.57	10.63
Orchard Grass	1	....	....	....	96.7	......	96.7	3.3	....	3.3	.80	2.50
Kentucky Bluegrass	1	....	....	....	99.4	......	99.4	.65	....	......	.50	.35
Hungarian	3	....	....	....	99.9	94.5	98.1	5.5	....	1.9	1.80	.70

* Foreign harmless seeds not included.

TABLE SHOWING THE KINDS OF WEED SEEDS FOUND IN SAMPLES OF SEEDS EXAMINED.

		Name of Samples Examined.								
		Red clover.	White clover.	Alsike.	Peavine.	Timothy.	Redtop.	Orchard grass.	Kentucky bluegrass.	Hungarian.
Common Name.	Technical Name.	45	1	24	1	51	7	1	1	3
Hedge Mustard	Sisymbrium officinale.	1	....	....	....	....	....	....	....	....
Black Mustard	Brassica nigra	4	....	....	....	3	....	....		1
Shepherd's Purse	Capsella bursa-pastoris	....	....	7	....	17	....	....	....	....
Wild Peppergrass	Lepidium virginicum.	....	....	1	....	....	3	1	....	....
Wild Peppergrass	Lepidium intermedium	....	....	1	....	....	....	....	....	....
Common Chickweed	Stellaria media	....	1	....	....	8	4	....	....	....
Spurry	Spergula arvensis	....	....	1	....	1	....	....	....	....
Evening Primrose	Œnothera biennis	....	....	1	....	1	....	....	....	....
Five Finger—Cinque Foil	Potentilla monspeliensis	....	....	....	....	3	5	....	....	....
Wild Carrot	Daucus carota	2	....	....	....	....	....	....	....	....
Cone Flower—Yellow Daisy	Rudbeckia hirta	....	....	....	....	10	....	....	....	....
May Weed	Anthemis cotula	1	....	1	....	2	....	....	....	....
Common Bur-Thistle.	Carduus lanceolatus	....	....	3	....	2	....	....	....	....
Spring Sow-Thistle	Sonchus asper	1	....	....	1	2	2	....	....	1
Corn Sow-Thistle	Sonchus arvensis	9	....	....	....	9	....	....	....	....
Roman Wormwood	Ambrosia artemesiæfolia	....	....	....	....	....	....	....	....	1
Ox-eye Daisy	Chrysanthemum leucanthemum	....	....	....	....	1	....	....	....	....
Blue Verbena	Verbena hastata	....	....	1	....	5	....	....	....	....
Catnip	Nepeta cataria	....	....	2	....	2	....	....	....	....
Heal All	Prunella vulgaris	....	....	2	....	2	....	....	....	....
Dooryard Plantain	Plantago major	3	....	2	....	5	....	....	....	....
Rugel's Plantain	Plantago rugelei	....	....	....	....	5	....	....	....	....
English Plantain	Plantago lanceolata	17	....	2	....	1	1	1	....	....
Awned Plantain	Plantago aristata	5	....	4	....	1	....	....	....	1
Prostrate Pigweed	Amaranthus blitoides.	2	....	....	....	....	....	....	....	....
Rough Pigweed	Amaranthus retroflexus	9	....	8	....	4	2	....	....	....
Goosefoot	Chenopodium album	12	1	8	....	14	....	....	....	3
Sorrel	Rumex acetosella	7	1	18	....	2	1	....	....	....
Pennsylvania Smartweed	Polygonum Pennsylvanicum	20	....	....	....	1	....	....	....	3
Lady's Thumb	Polygonum persicariæ	7	....	....	....	1	....	....	....	....
Black Bindweed	Polygonum convolvulus	12	1	13	....	6	....	1	1	....
Yellow Foxtail	Setaria glauca	1	....	....	....	....	....	....	....	....
Green Foxtail	Setaria viridis	6	....	....	....	....	....	....	....	....

BOX EXPERIMENTS WITH PHOSPHORIC ACID FROM DIFFERENT SOURCES.

L. H. Merrill.

For several years a series of experiments have been in progress at this Station designed to show the relative availability of phosphoric acid as supplied in several common forms, and also the varying ability of some of our common crops to obtain phosphoric acid from the same source. The results obtained up to the close of 1895 were published in the report of this Station for that year, and also in Bulletin 34. While the work cannot be considered complete, yet as it is necessary to leave it for a time, it seems desirable to bring together all the results thus far obtained, including those previously published. In order to make the report complete in itself much of the explanatory matter is also reprinted.

COMMERCIAL PHOSPHATES.

Phosphate of Lime.—Nearly all the phosphoric acid found in our markets and used for fertilizing purposes is in combination with lime as phosphate of lime. Three forms are in common use, viz.:

1. Insoluble phosphate of lime. This is the form in which nearly all the phosphates exist in nature and from which the second and third forms described below are derived. Bones are made up largely of this substance and are accordingly extensively used in the preparation of commercial phosphates; but the chief source of the insoluble phosphate now used in this country is rock phosphate, large deposits of which are found in South Carolina and Florida. It is insoluble in water and, unless finely ground, its phosphoric acid is given up very slowly to the plant. This is the tricalcic phosphate of chemists.

2. Soluble phosphate of lime. When the insoluble phosphate is treated with dilute sulphuric acid a large part of the lime

unites with the acid to form sulphate of lime. The remaining phosphate, containing much less lime than the original, is soluble in water and is hence known as soluble phosphate, or, on account of the excess of phosphoric acid, as "superphosphate." The soluble phosphate is in a condition to be immediately used by the plant. It possesses the additional advantages that by dissolving in the soil waters is becomes quickly and uniformly distributed through the soil, where the plant roots must everywhere come into contact with it. It is the most expensive of the three forms. This is also known as the monocalcic phosphate.

3. Reverted or citrate soluble phosphoric acid. If a soluble phosphate is allowed to stand for a long time it frequently happens that much of the soluble phosphate undergoes a change, passing into a form insoluble in water but much more available to the plant than the original insoluble phosphate from which it was derived. This is the reverted or citrate soluble phosphate. It was formerly supposed to be of much less value than the soluble form, but experience has shown that there is but little difference as regards actual availability. In fact, if a soluble phosphate is added to the soil, a large part of it "reverts" before the crops have had time to take it up. It is known as the citrate soluble phosphate because, unlike the insoluble form, it is readily soluble in a hot solution of ammonium citrate. This reagent is therefore employed in the laboratory to distinguish the form in question. The soluble and citrate phosphates are often classed together as available.

The reverted or citrate soluble phosphate may or may not consist of dicalcic phosphate. While the dicalcic phosphate possesses the characters ascribed to the third form mentioned, yet it is found that in some cases the ammonium citrate will dissolve a considerable quantity of the tricalcic phosphate, the amount standing in intimate relation to the degree of fineness to which the phosphate has been reduced. The citrate, then, does not afford us the means of distinguishing sharply between the dicalcic and tricalcic phosphates. This fact, however, in no way affects the assumption that the citrate soluble phosphate is available to the plant.

It should be added also that the so-called insoluble does not strictly correspond to the tricalcic phosphate, for the reason just

mentioned—a part of this form may go into solution with the citrate and be reckoned with the available.

In the manufacture of superphosphates the conversion of insoluble into soluble phosphates is never complete, a part being unacted upon by the acid and remaining in the insoluble form. Moreover, as we have seen, a part of the soluble phosphate reverts, especially on long standing. In practice, therefore, we always find a superphosphate to consist of a mixture of the three forms referred to. There must always be present sulphate of lime and the impurities found in the original phosphate.

Redonda Phosphate.—In another class of phosphates, not so generally used, the phosphoric acid is combined with iron and alumina, instead of with lime. These phosphates are not only insoluble in water, and but very slightly soluble in hot ammonium citrate, but they are even less available to the plant than the corresponding phosphates of lime. When treated with sulphuric acid they prove very difficult of management, giving a pasty mass which cannot be readily dried off.

A phosphate of this description is quarried at Redonda, a small island in the West Indies, and is known as Redonda phosphate or Redondite. It is a characteristic of this phosphate that at a high temperature it loses water, and at the same time becomes largely soluble in ammonium citrate. On long standing a reverse action takes place, the phosphate passing again to the insoluble condition. It is probable that the reversion is more rapid when the roasted Redonda has been applied to the soil. Comparatively little of this phosphate is sold, yet on account of the high percentage of phosphoric acid which it carries and the ease with which it may be converted into the citrate soluble condition, it would prove a valuable fertilizer if it is as available to the plant as the chemical analysis would seem to indicate.

PHOSPHATES USED IN BOX EXPERIMENTS.

In the experiments here recorded, three forms of phosphates were used:

1. Acid Florida rock. This was prepared by treating a Florida phosphatic rock with sulphuric acid, thereby converting a large part of the phosphate into an available form. At the

beginning of the first experiment this phosphate had the following composition: 20.60 per cent total phosphoric acid, of which 16.90 per cent was available (14.97 per cent soluble, 1.93 per cent citrate soluble). In the later work it was found that the composition had changed somewhat, but the amount of available phosphate remained about the same.

2. Crude, finely ground Florida rock (floats), containing 32.88 per cent total phosphoric acid, none of which was soluble, with only 2.46 per cent soluble in ammonium citrate. This was obtained from the commercial ground rock by stirring it with water, allowing the coarse particles to subside and then pouring off the turbid water. The "floats" used in this experiment consisted of the sediment deposited from these washings.

3. A phosphate of iron and alumina (Redonda). The first sample used contained 49.58 per cent phosphoric acid, a large part of which, 42.77 per cent, was soluble in ammonium citrate. The Redonda underwent such rapid changes in the intervals between the experiments that it became necessary to prepare fresh quantities at each successive planting. The analysis given above is fairly representative of all.

Twenty grams of the floats, containing 6.58 grams total phosphoric acid, were used for a single box. The other phosphates used were first analyzed and such quantities used for each box that the total quantity present was in each case the same, 6.58 grams. The actual amounts of available phosphoric acid thus supplied to each box by the various phosphates were: by the acid rock, 5.39 grams; by the floats, .49 grams; by the Redonda, 5.67 grams.

DETAILS OF THE EXPERIMENT.

The experiments were conducted in one of the green houses, the plants being grown in wooden boxes, fourteen inches square and twelve inches deep. When filled to within one and one-half inches of the top, these boxes contained 120 pounds of sand. The sand used was taken from a knoll near the river at a depth of three or four feet, and was nearly free from organic matter. Traces of phosphoric acid were present, but as this was in the insoluble form and the quantity in each box was the same, its presence is not considered objectionable. The sand was care-

fully screened before being used and thoroughly mixed with the phosphates and other plant foods.

In each period twelve boxes were used for each kind of plant. In the first box the acid rock was used; in the second, the untreated Florida rock, or "floats;" in the third, the phosphate of iron and alumina, or Redonda; the fourth box received no phosphate. The next four boxes were treated in the same manner, and so on to the end. Thus it will be seen that for each kind of plant there were three boxes which received exactly the same treatment. In addition to the phosphates, each box received ten grams sodium nitrate, five grams potassium chloride and five grams magnesium sulphate. In the boxes where the Redonda was used, ten grams calcium sulphate were also added. It was intended to supply all the elements essential to the healthy development of the plants except that every fourth box received no phosphate. All the other conditions were made as uniform as possible in order that the differences in growth might fairly be attributed to the differences in the phosphates used.

KINDS OF PLANTS GROWN.

Eighteen species of plants were chosen, representing seven orders: peas, horse-beans, clover and alfalfa (Leguminosæ); turnips, ruta-bagas, cauliflower and kohl-rabi (Cruciferæ); barley, corn, oats and timothy (Gramineæ); tomatoes and potatoes (Solanaceæ); carrots and parsnips (Umbelliferæ); buckwheat (Polygonaceæ); sunflowers (Compositæ).

It was intended to carry each plant through three periods of growth, but the clover, the common red species (T. pratense), could not be matured in the time required for the other plants and but two crops were grown. The sunflower and buckwheat did not thrive under the conditions of the experiment and after a single trial were replaced by carrots and parsnips, which were grown for the two following periods. The seed was carefully selected, that only being used which was well formed and of uniform size. Of the larger plants, four or five were grown to each box. The smaller plants were thinned so that the number to each box was uniform for that plant. Such leaves as ripened before the plants matured were removed, dried and added to the plants when harvested. No attempt was made at pollination.

As very few insects were present during the growth of the plants, the fruiting, as might have been expected, was very irregular. As soon as the plants seemed to have attained their maximum development, they were harvested, dried, weighed, and the total amount of dry matter determined for each crop grown. In the diagrams that follow the average production for a single period is shown, the heavy lines representing the relative weights of dry matter, and the last column the weights in grams.

DIAGRAM SHOWING RELATIVE WEIGHTS OF DRY MATTER OF PLANTS GROWN WITH PHOSPHORIC ACID FROM DIFFERENT SOURCES.

Crops.	Phosphate.	Comparative Scale.	Weight.
			Grams.
Peas.	Acid rock.		167
	Floats.		122
	Redonda.		94
	No phosphate.		87
Horse beans.	Acid rock.		269
	Floats.		128
	Redonda.		118
	No phosphate.		86
Clover.	Acid rock.		217
	Floats.		169
	Redonda.		126
	No phosphate.		83
Alfalfa.	Acid rock.		107
	Floats.		97
	Redonda.		87
	No phosphate.		90
Turnips.	Acid rock.		222
	Floats.		202
	Redonda.		187
	No phosphate.		119
Ruta-bagas.	Acid rock.		152
	Floats.		145
	Redonda.		122
	No phosphate.		64
Cauli-flower.	Acid rock.		176
	Floats.		167
	Redonda.		107
	No phosphate.		62
Kohl-rabi.	Acid rock.		232
	Floats.		209
	Redonda.		172
	No phosphate.		130
Barley.	Acid rock.		338
	Floats.		171
	Redonda.		186
	No phosphate.		146
Corn.	Acid rock.		218
	Floats.		85
	Redonda.		98
	No phosphate.		31
Oats.*	Acid rock.		662
	Floats.		307
	Redonda.		380
	No phosphate.		319
Timothy.*	Acid rock.		410
	Floats.		329
	Redonda.		346
	No phosphate.		353

*In the case of the oats and timothy the scale has been reduced one-half to accommodate the lines to the space allowed. The *relative* length of the lines for the *same plant* has been maintained.

RELATIVE WEIGHTS OF DRY MATTER OF PLANTS GROWN WITH PHOSPHORIC ACID—CONCLUDED.

Crops.	Phosphate.	Comparative Scale.	Weight.
			Grams.
Tomatoes.	Acid rock.		135
	Floats.		92
	Redonda.		79
	No phosphate.		36
Potatoes.	Acid rock.		260
	Floats.		187
	Redonda.		156
	No phosphate.		151
Carrots.	Acid rock.		214
	Floats.		141
	Redonda.		149
	No phosphate.		135
Parsnips.	Acid rock.		237
	Floats.		151
	Redonda.		155
	No phosphate.		163
Buck-wheat.	Acid rock.		107
	Floats.		54
	Redonda.		51
	No phosphate.		37
Sun-flowers.	Acid rock.		101
	Floats.		14
	Redonda.		15
	No phosphate.		11
Turnips, roots.	Acid rock.		100
	Floats.		70
	Redonda.		90
	No phosphate.		44
Rutabagas roots.	Acid rock.		62
	Floats.		47
	Redonda.		32
	No phosphate.		16
Cauli-flower, edible portion.	Acid rock.		50
	Floats.		19
	Redonda.		—
	No phosphate.		—
Kohl-rabi, edible portion.	Acid rock.		153
	Floats.		129
	Redonda.		92
	No phosphate.		60
Potatoes, tubers.	Acid rock.		185
	Floats.		131
	Redonda.		140
	No phosphate.		115
Carrots, roots.	Acid rock.		173
	Floats.		109
	Redonda.		113
	No phosphate.		102
Parsnips, roots.	Acid rock.		196
	Floats.		115
	Redonda.		114
	No phosphate.		120

RESULTS.

In every case the acid rock gave the best returns. The gain was especially marked with the family Gramineæ, three members of which, the barley, corn and oats, yielded nearly double the amount produced by either the floats or Redonda. The effect upon the sunflowers and buckwheat was equally marked; but if these plants could have been brought to full development it is probable that the gain would have been less apparent.

If we compare the amount of dry matter produced by the acid rock with that produced by the floats for all the crops grown, we find the balance in favor of the acid rock to be 52 per cent. In other words, the effect of the available phosphoric acid as compared with the insoluble phosphate was to increase the product more than one-half.

In nearly every case the floats gave results second only to those obtained with the acid rock. With this phosphate the Cruciferæ gave returns within ten per cent of those obtained by the acid rock. This is not true of the edible portion of these plants, however, for there the good effects of the acid rock were more marked.

Of the three forms of phosphate used, the Redonda proved the least valuable, though supplying a larger amount of available phosphoric acid than the acid rock. In most cases it showed itself inferior even to the floats. The Gramineæ furnished an interesting exception to this rule, yielding results with Redonda above those given by the floats.

The small yield from the boxes in which no phosphate was used is sufficient indication of the extreme poverty of the soil, and confirms the belief that the amount of phosphoric acid thus supplied is not sufficiently large to seriously affect the experiment.

It is interesting to note that plants of the same family show a remarkable agreement in their behavior towards the various phosphates. The striking manner in which the Gramineæ responded to the stimulus of the acid rock has already been alluded to. In no other case is the effect so marked. Another peculiarity of the members of this family is shown in their conduct toward the Redonda. The relative value of this phosphate and floats is here the reverse of that shown by nearly all the

other plants. The failure of the Cruciferæ to respond to the acid rock furnishes a good illustration of a similar kind. The Umbelliferæ, though responding to the acid rock, seem to derive no benefit from either the floats or Redonda, since neither of the phosphates increase the yield above that obtained where no phosphate was used. This is true both of the whole plant and the roots.

The alfalfa shows a strange indifference to the precise form in which the phosphoric acid is supplied. The crop was light in every case, and the phosphoric acid already present in the barren soil used, seems to have sufficed for the slender product.

STIMULATING EFFECT OF ACID PHOSPHATE IN THE EARLY STAGES OF GROWTH.

A report of this work would be incomplete if it failed to take note of certain facts observed in the course of the experiment which cannot be shown in the diagram, where only the final results are given.

Throughout the whole series of experiments the effect of the acid rock was marked, the plants receiving it in nearly every case at once taking the lead, and keeping it to the end. This stimulating effect upon the young plant is shown in the accompanying cuts of the immature clover and timothy. The horse-beans furnish a marked exception to this rule, the more nearly equal development being perhaps due to the large amount of nutriment stored in the seed. When this supply was exhausted, the phosphoric acid hunger manifested itself, the effect being shown in the cut of the same plant at a later period.

In by far the larger number of cases, especially with the clover, timothy, turnips and ruta-bagas, the good effects of the acid rock were more marked during the first few weeks of growth than at a later stage, when the roots had become more fully developed, and had begun to forage for themselves. This fact, also, is shown in the cuts of the clover and timothy. It would appear that the young plants feed but little upon the insoluble phosphates; but that the organic acids present in the sap of the roots exert a solvent action upon the insoluble phosphates in the soil, gradually converting them into available forms.

It will be noticed that in this work only the immediate effect of the phosphates has been taken into consideration, no mention having been made of the unused phosphoric acid remaining in the soil at the close of the experiment. In actual field work the good effect of the ground rock would, of course, be far more lasting than that of the acid rock.

Box experiments were made at the New Hampshire Experiment Station in 1893 with winter rye, the phosphoric acid being supplied by roasted Redonda, ground bone, and basic slag. The result showed that the rye gave nearly as good returns with the roasted Redonda as with the other phosphates. This result confirms the work here reported. It will be seen by reference to the diagram here given that the corn, barley, oats and timothy (plants closely related to rye) gave better results with the Redonda phosphate than with the finely ground Florida rock.

SUMMARY.

1. Plants differ in their ability to feed upon crude phosphates.

2. Turnips, ruta-bagas, cauliflowers and kohl-rabi gave nearly as good returns with the Florida rock as with the acid rock.

3. In every other case the good effect of the acid rock was very marked.

4. In most cases the crude Florida rock yielded better returns than the Redonda.

5. Barley, corn and oats seem to require an acid phosphate.

6. When early maturity is desired, the acid rock can profitably be used.

7. The largely increased production obtained by the use of the acid rock will often determine the success of the crop.

8. The solubility of a phosphate in ammonium citrate is not always the correct measure of its actual value to the plant.

CLOVER. IMMATURE.

CLOVER. MATURE.

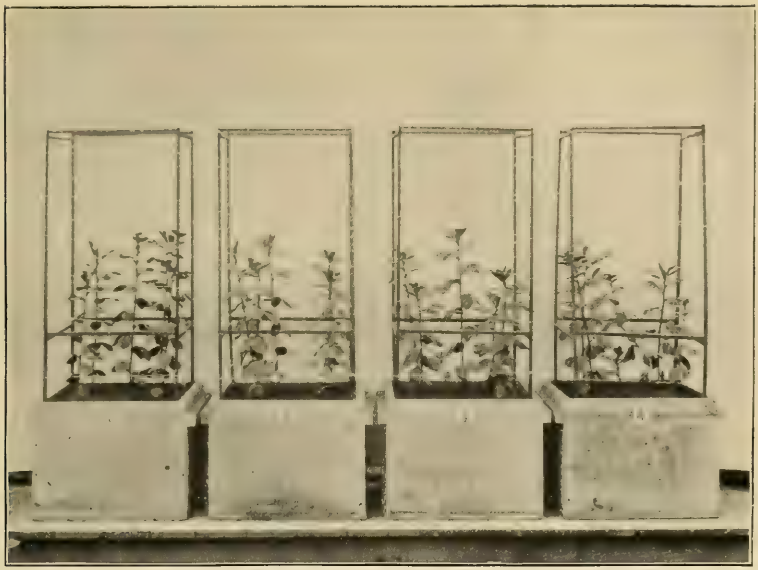
ALFALFA.

Box 1. Soluble phosphoric acid.

Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.



HORSE BEANS, IMMATURE.

HORSE BEANS, MATURE.

Box 1. Soluble phosphoric acid.

Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.

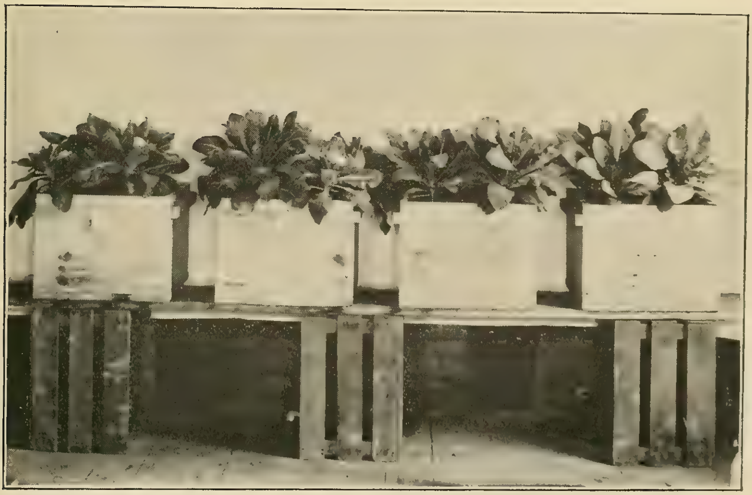
BARLEY.

OATS.

Box 1. Soluble phosphoric acid.
Box 2. Insoluble phosphoric acid—Florida rock.
Box 3. Insoluble phosphate of iron and alumina.
Box 4. No phosphate added.

TURNIPS.

RUTA-BAGAS.



CAULIFLOWER.

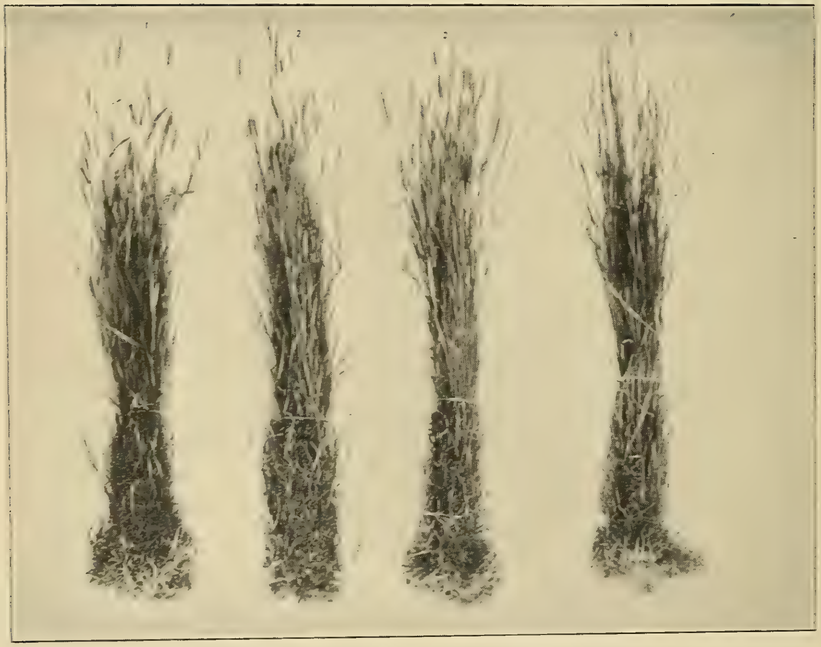
Box 1. Soluble phosphoric ac'd.

Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.

TIMOTHY, IMMATURE.



TIMOTHY, MATURE.

Box 1. Soluble phosphoric acid.

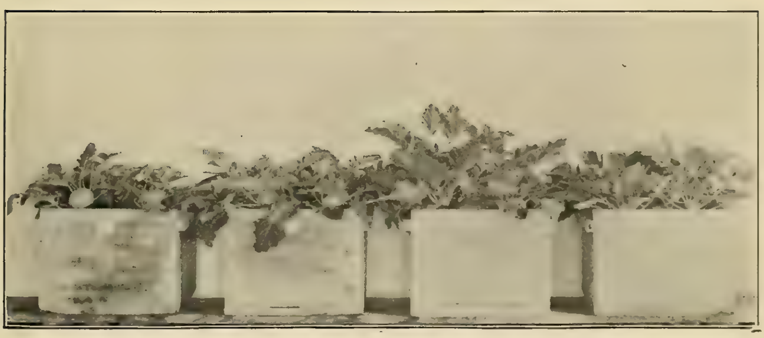
Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.

POTATOES.

TOMATOES.



KOHL-RABI.

Box 1. Soluble phosphoric acid.

Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.

CARROTS.

PARSNIPS.

Box 1. Soluble phosphoric acid.

Box 2. Insoluble phosphoric acid—Florida rock.

Box 3. Insoluble phosphate of iron and alumina.

Box 4. No phosphate added.

ANALYSES OF FODDERS AND FEEDING STUFFS.

In connection with the work of the Station, analyses of the following miscellaneous feeding stuffs have been made by the Station chemists. For the most part the analyses were made in connection with the feeding experiments or experiments upon the growth of plants. In no case were they undertaken merely to increase the amount of this class of data. The methods of analyses recommended by the Association of Official Agricultural Chemists were employed.

The results of the analyses are given in the tables which follow:

COMPOSITION OF FODDERS AND FEEDING STUFFS ANALYZED AND NOT PREVIOUSLY PUBLISHED, CALCULATED TO WATER CONTENT AT TIME OF TAKING SAMPLE.

	Laboratory number.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%
Bran	4015	9.83	5.47	16.31	8.93	53.96	5.50
Bran	4081	8.15	5.38	16.94	7.38	57.80	4.35
Bran	4107	9.65	6.71	16.56	8.56	53.36	5.16
Bran	4137	10.25	6.82	16.06	9.05	53.04	4.78
Corn Meal	4014	12.40	1.47	10.63	2.33	69.04	4.13
Corn Meal	4082	9.92	1.51	10.50	2.08	71.88	4.11
Corn Meal	4111	14.11	1.40	9.81	1.89	69.10	3.69
Corn Meal	4136	12.55	1.61	9.63	2.19	69.96	4.06
Cottonseed Meal	4083	5.27	5.49	52.25	3.81	21.08	12.10
Cottonseed Meal	4139	8.31	7.82	43.81	5.61	24.51	9.94
Cottonseed Meal	8044	6.57	5.97	51.06	5.44	20.87	10.09
Cottonseed Meal	8058	6.06	6.23	48.25	5.06	23.43	10.97
Chicago Gluten Meal	4016	10.11	1.38	36.00	3.86	40.49	8.16
Chicago Gluten Meal	4041	5.55	1.21	37.50	2.83	43.98	8.93
Chicago Gluten Meal	4106	10.40	1.15	36.75	1.59	47.24	2.87
Chicago Gluten Meal	4126	11.00	1.25	41.44	1.82	43.49	1.00
Chicago Gluten Meal	4141	12.94	1.42	40.31	2.00	40.96	2.37
King Gluten Meal	4018	9.53	1.94	26.31	2.45	44.59	15.18
King Gluten Meal	4140	6.72	1.81	35.94	2.36	35.45	17.72
King Gluten Meal	8011	3.48	.91	34.26	1.72	44.98	14.65
King Gluten Meal	8012	7.08	1.92	33.00	1.98	36.21	19.81
King Gluten Meal	8013	3.00	.53	35.37	2.01	41.62	17.47
Blatchford's Calf Meal	8273	7.70	5.46	25.63	5.28	50.37	5.56
Cleveland Flax Meal	4108	8.83	5.41	40.25	7.27	33.66	4.58
Linseed Meal	8057	9.10	5.39	35.19	9.05	34.84	6.43
Buffalo Gluten Feed	4095	9.32	3.53	27.25	6.69	50.10	3.11
Diamond Gluten Feed	8190	9.11	1.00	25.75	7.35	52.77	4.02
Gluten Feed	8047	9.15	3.38	28.19	6.89	49.42	2.97

COMPOSITION OF FODDERS AND FEEDING STUFFS—CONCLUDED.

	Laboratory number.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%	%	%	%
Gluten Feed	8188	8.98	2.83	27.50	6.82	50.90	2.97
Gluten Feed	8189	9.63	1.01	24.31	7.14	53.97	3.94
Mixed Feed	8276	11.16	4.42	14.94	5.30	60.38	3.80
Quaker Oat Feed	8046	8.33	5.10	11.38	18.18	53.41	3.60
The H-O Co.'s Poultry Feed	8038	8.46	2.71	18.00	4.65	60.71	5.47
The H-O Co.'s Poultry Feed	8271	10.39	2.87	16.75	5.02	59.21	5.76
The H-O Co.'s Poultry Feed	8362	10.36	3.09	16.94	4.61	59.45	5.55
The H-O Co.'s Scratching Feed for Poultry	8049	9.83	1.92	16.19	2.23	65.65	4.18
The H-O Co.'s Dairy Feed	8039	7.03	3.93	19.56	12.75	52.14	4.59
The H-O Co.'s Dairy Feed	8269	9.66	4.16	19.00	12.23	49.40	5.55
The H-O Co.'s Dairy Feed	8040	7.27	3.60	18.06	13.69	52.80	4.58
The H-O Co.'s Dairy Feed	8361	9.66	4.06	16.56	12.87	52.80	4.05
The H-O Co.'s Dairy Feed	8472	8.89	3.62	17.63	13.77	51.70	4.39
The H-O Co.'s Standard Horse Feed	8040	9.31	3.27	14.06	9.64	59.71	4.01
The H-O Co.'s Horse Feed	8270	12.07	3.35	10.38	10.61	59.62	3.97
The H-O Co.'s Horse Feed	8360	10.35	3.54	10.75	11.48	59.81	4.07
The H-O Co.'s Horse Feed	8473	9.38	2.87	11.81	10.03	61.64	4.27
The H-O Co.'s Horse Feed	8474	9.39	2.99	11.69	11.84	59.99	4.10
The H-O Co.'s Horse Feed	4080	11.06	3.24	13.44	9.80	58.56	3.90
The H-O Co.'s Scotch Oat Feed	8268	11.56	5.10	10.00	13.53	54.45	5.36
The H-O Co.'s "Victor" Corn, Oat and Barley Chop	8045	8.45	3.88	10.75	12.87	59.50	4.55
The H-O Co.'s De Fi Chop	8462	8.43	4.33	8.38	14.63	61.28	2.95
The H-O Co.'s Oat Bran	8471	7.54	6.03	10.88	19.14	51.03	5.38
Buckwheat Middlings	8363	13.81	4.57	25.56	12.86	36.66	6.54
Buckwheat Middlings	8379	11.29	4.69	25.56	10.68	40.35	6.43
Wheat Middlings	8056	9.93	3.45	17.38	5.53	58.82	4.89
Wheat Middlings	8060	10.05	2.84	17.44	3.72	61.66	4.29
Oat Middlings	8053	6.95	3.07	18.31	3.86	59.56	8.25
Oat Bran	8059	6.14	6.38	14.00	19.86	48.63	4.99
Oatena	8465	7.90	4.80	9.19	17.06	57.46	3.59
Ground Oat Hulls	8055	6.76	6.37	3.13	32.48	49.19	2.07
Grain Hulls	4109	11.01	11.22	11.75	16.15	47.57	2.30
Corn Germs	4110	4.76	1.96	15.31	6.65	24.91	46.41
Ground Corn	8054	11.88	1.07	10.19	1.80	71.67	3.39
Oat Hay—cut when in bloom	4097	26.46	5.55	7.25	26.99	31.90	1.85
Oat Hay—cut when grain was in milk	4096	26.59	4.57	7.77	23.14	35.54	2.39
Oat Hay—cut when grain was in dough	4089	16.30	5.21	6.47	26.58	42.60	2.84
Oat Hay—cut when part of heads were in bloom, part in milk	4127	13.76	6.33	8.80	28.87	39.38	2.86
Oat Hay—cut when part of the heads were in milk, part in dough	4130	13.28	6.25	6.59	29.45	41.13	3.30
Oat Hay—first 8 inch section of bottom of stalk	4134	9.80	6.17	2.50	39.23	40.58	1.72
Oat Hay—second 8 inch section of stalk	4135	10.00	7.35	4.31	37.43	38.91	2.00
Oat Hay—top of plant	4133	11.33	6.22	8.53	24.68	45.88	3.36
Silage—Sanford corn, very immature, no ears	4125	87.62	.98	1.50	3.56	5.90	.44
Corn Silage	4138	81.75	.91	1.92	4.70	9.89	.83
Corn Silage	8061	71.21	1.38	2.94	6.72	16.65	1.10
Hay	4117	18.19	5.01	6.88	24.52	43.44	1.96

COMPOSITION OF WATER FREE SUBSTANCE OF FODDERS AND FEEDING STUFFS ANALYZED AND NOT PREVIOUSLY PUBLISHED.

	Laboratory number.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%
Bran	4015	6.06	18.09	9.90	59.85	6.10
Bran	4081	5.86	18.45	8.04	62.92	4.73
Bran	4107	7.43	18.33	9.47	59.06	5.71
Bran	4137	7.60	17.89	10.09	59.10	5.32
Corn Meal	4014	1.67	12.13	2.68	78.81	4.71
Corn Meal	4082	1.67	11.66	2.31	79.80	4.56
Corn Meal	4111	1.63	11.42	2.20	80.45	4.30
Corn Meal	4136	1.84	11.00	2.50	80.02	4.64
Cottonseed Meal	4083	5.80	55.16	4.02	22.25	12.77
Cottonseed Meal	4139	8.53	47.79	6.12	26.73	10.83
Cottonseed Meal	8044	6.39	54.65	5.82	22.34	10.80
Cottonseed Meal	8058	6.63	51.36	5.39	24.94	11.68
Chicago Gluten Meal	4016	1.53	40.05	4.29	45.05	9.08
Chicago Gluten Meal	4041	1.28	39.70	3.00	46.56	9.46
Chicago Gluten Meal	4106	1.28	41.02	1.77	52.73	3.20
Chicago Gluten Meal	4126	1.40	46.56	2.05	48.87	1.12
Chicago Gluten Meal	4141	1.63	46.30	2.30	47.05	2.72
King Gluten Meal	4018	2.14	29.08	2.70	49.30	16.78
King Gluten Meal	4140	1.94	38.53	2.53	38.00	19.00
King Gluten Meal	8011	.94	35.50	1.78	46.60	15.18
King Gluten Meal	8012	2.06	35.52	2.13	38.97	21.32
King Gluten Meal	8013	.55	36.46	2.07	42.91	18.01
Blatchford's Calf Meal	8273	5.92	27.77	5.72	54.57	6.02
Cleveland Flax Meal	4108	5.93	44.15	7.97	36.92	5.03
Linseed Meal	8057	5.93	38.72	9.95	38.33	7.07
Buffalo Gluten Feed	4095	3.89	30.06	7.37	55.25	3.43
Diamond Gluten Feed	8190	1.10	28.33	8.09	58.06	4.42
Gluten Feed	8047	3.72	31.03	7.58	54.40	3.27
Gluten Feed	8188	3.11	30.23	7.48	55.92	3.26
Gluten Feed	8189	1.12	26.91	7.90	59.71	4.36
Mixed Feed	8276	4.98	16.82	5.97	67.96	4.27
Quaker Oat Feed	8046	5.56	12.41	19.83	58.27	3.93
The H-O Co.'s Poultry Feed	8038	2.96	19.66	5.08	66.32	5.98
The H-O Co.'s Poultry Feed	8271	3.20	18.69	5.60	66.08	6.43
The H-O Co.'s Poultry Feed	8362	3.45	18.90	5.14	66.33	6.18
The H-O Co.'s Scratching Feed for Poultry	8049	2.13	17.95	2.47	72.81	4.64
The H-O Co.'s Dairy Feed	8039	4.23	21.04	13.72	56.08	4.93
The H-O Co.'s Dairy Feed	8269	4.60	21.03	13.54	54.69	6.14
The H-O Co.'s Dairy Feed	8640	3.88	19.47	14.76	56.95	4.94
The H-O Co.'s Dairy Feed	8361	4.49	18.33	14.25	58.45	4.48
The H-O Co.'s Dairy Feed	8472	3.97	19.35	15.11	56.75	4.82
The H-O Co.'s Standard Horse Feed	8040	3.60	15.51	10.63	65.84	4.42
The H-O Co.'s Horse Feed	8270	3.81	11.80	12.07	67.80	4.52
The H-O Co.'s Horse Feed	8360	3.95	11.98	12.81	66.72	4.54
The H-O Co.'s Horse Feed	8473	3.17	13.03	11.07	68.02	4.71
The H-O Co.'s Horse Feed	8474	3.30	12.90	13.07	66.21	4.52
The H-O Co.'s Horse Feed	4080	3.64	15.11	11.02	65.84	4.39
The H-O Co.'s Scotch Oat Feed	8268	5.77	11.31	15.30	61.56	6.06
The H-O Co.'s "Victor" Corn, Oat and Barley Chop	8045	4.24	11.73	14.06	65.00	4.97
The H-O Co.'s De Fi Chop	8462	4.73	9.15	15.97	66.93	3.22
The H-O Co.'s Oat Bran	8471	6.52	11.77	20.70	55.19	5.82
Buckwheat Middlings	8363	5.30	29.66	14.92	42.53	7.89
Buckwheat Middlings	8379	5.29	29.94	12.04	45.48	7.25
Wheat Middlings	8056	3.83	19.29	6.14	65.31	5.43
Wheat Middlings	8060	3.16	19.39	4.14	68.54	4.77
Oat Middlings	8053	3.30	19.68	4.15	64.01	8.86
Oat Bran	8059	6.80	14.92	21.16	51.80	5.32
Oatena	8465	5.21	9.98	18.52	62.39	3.90
Ground Oat Hulls	8055	6.83	3.35	34.84	52.76	2.22
Grain Hulls	4109	12.61	13.21	18.15	53.45	2.58
Corn Germs	4110	2.05	16.08	6.98	26.16	48.73
Ground Corn	8054	1.21	11.56	2.04	81.34	3.85

COMPOSITION OF WATER FREE SUBSTANCE OF FODDERS AND FEEDING STUFFS—CONCLUDED.

	Laboratory number.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%
Oat Hay—cut when in bloom	4097	7.55	9.86	36.70	43.38	2.51
Oat Hay—cut when grain was in milk	4096	6.23	10.58	31.53	48.41	3.25
Oat Hay—cut when grain was in dough	4089	6.23	7.73	31.74	50.91	3.39
Oat Hay—cut when part of the heads were in bloom and part in milk	4127	7.34	10.20	33.48	45.66	3.32
Oat Hay—cut when part of the heads were in milk and part in dough	4130	7.21	7.60	33.96	47.42	3.81
Oat Hay—first 8 inch section of bottom of stalk	4134	6.84	2.77	43.49	45.00	1.90
Oat Hay—second 8 inch section of stalk	4135	8.16	4.79	41.60	43.23	2.22
Oat Hay—top of plant	4133	7.01	9.62	27.83	51.75	3.79
Silage—Sanford corn, very immature, no ears	4125	7.93	12.12	28.75	47.62	3.58
Corn Silage	4138	5.01	10.52	25.75	54.19	4.53
Corn Silage	8061	4.79	10.21	23.34	57.84	3.82
Hay	4117	6.13	8.41	29.97	53.10	2.39

DIGESTION EXPERIMENTS WITH SHEEP.

J. M. Bartlett.

The digestion experiments, the results of which are presented in the following pages, were not all made during 1898—three of them being made in 1897. The general plan was the same as heretofore followed. Sheep were the animals used and the feeding periods consisted of seven days preliminary feeding and five days for the experiment.*

The materials of which the digestibility was determined were:

1st. Oat Hay; cut in bloom.

2d. Oat Hay; cut when the grain was in milk.

3d. Oat Hay; cut when the grain was in dough.

4th. Oat Hay; cut when partly in bloom and partly in milk.

5th. Oat Hay; cut when the grain was partly in milk and partly in dough stage.

6th. H-O Horse-feed.

7th. Flax meal.

DIGESTION EXPERIMENT 63—(OAT HAY IN BLOOM.)

RATIONS.

Fed daily, Sheep No. I, 600 grams per day.

Fed daily, Sheep No. II, 600 grams per day.

Fed daily, Sheep No. III, 800 grams per day.

Fed daily, Sheep No. IV, 200 grams per day.

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*Digestion experiments with sheep have been conducted at this station since 1885, and the results are given in the Reports for 1886, 1887, 1888, 1889, 1890, 1891, 1893, 1894, 1896 and 1897. The Report for 1891 contains a description of the digestion room, stalls, harness, etc., used in the experiments.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free. Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDER.		%	%	%	%	%	%	%	%
Oat hay (cut when in bloom)	4097	73.53	92.45	7.55	9.86	36.70	43.38	2.51	4502
FECES.									
Sheep I	4102	....	91.65	8.35	9.65	33.39	46.06	2.55	4744
Sheep II.	4103	....	93.01	6.99	8.83	34.38	46.93	2.87	4891
Sheep III	4104	....	91.57	8.43	9.22	33.93	45.76	2.66	4723
Sheep IV	4105	....	89.43	10.57	12.87	26.44	46.80	3.32	4736

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Oat hay (cut when in bloom)	2205.9	2039.4	166.5	217.5	809.4	957.3	55.2
Feces	1051.7	963.9	87.8	101.5	351.1	484.6	26.7
Digested	1154.2	1075.5	78.7	116.0	458.3	472.7	28.5
Per cent digested	52.3	52.2	47.3	53.3	56.6	49.4	51.6
SHEEP II.							
Oat hay (cut when in bloom)	2205.9	2039.4	166.5	217.5	809.4	957.3	55.2
Feces	1084.6	1008.8	75.8	95.7	373.0	509.0	31.1
Digested	1121.3	1030.6	90.7	121.8	436.4	448.3	24.1
Per cent digested	50.8	50.5	54.5	56.0	53.9	46.8	43.7
SHEEP III.							
Oat hay (cut when in bloom)	2941.2	2719.2	222.0	290.0	1079.2	1276.4	73.6
Feces	1332.4	1220.0	112.4	122.8	452.0	609.7	35.5
Digested	1608.8	1499.2	109.6	167.2	627.2	666.7	38.1
Per cent digested	54.7	51.4	49.3	57.7	58.1	52.2	51.8
SHEEP IV.							
Oat hay (cut when in bloom)	735.3	679.8	55.5	72.5	269.8	319.1	18.4
Feces	298.3	266.8	31.5	38.4	78.9	139.6	9.9
Digested	437.0	413.0	24.0	34.1	190.9	179.5	8.5
Per cent digested	59.4	60.8	43.2	46.9	70.8	56.3	46.2
Average	54.3	53.7	48.6	53.5	59.9	51.2	48.3

FUEL VALUE OF FOOD FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	9931	4990	4941	101	5042	50.77
Sheep II	9931	5306	4625	106	4731	47.64
Sheep III	13241	6294	6947	145	7092	53.56
Sheep IV	3310	1412	1898	30	1928	58.25

DIGESTION EXPERIMENT 64—(OAT HAY IN MILK.)

RATIONS.

Fed daily, Sheep I, 800 grams per day.
Fed daily, Sheep II, 400 grams per day.
Fed daily, Sheep III, 800 grams per day.
Fed daily, Sheep IV, 400 grams per day.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water Free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDER.		%	%	%	%	%	%	%	
Oat hay (cut when in milk)	4096	73.41	93.77	6.23	10.58	31.53	48.41	3.25	4561
FECES.									
Sheep I	4098	-	92.28	7.72	8.64	33.63	47.00	3.01	4763
Sheep II	4099	-	92.41	7.59	8.97	33.88	47.18	2.38	4839
Sheep III	4100	-	90.63	9.37	8.97	34.95	44.52	2.19	4628
Sheep IV	4101	-	90.22	9.78	12.10	28.97	46.16	2.99	4766

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams	Grams	Grams.	Grams.	Grams.	Grams.	Grams.
Oat hay (cut when in milk)	2805.2	2632.8	172.4	303.0	878.6	1359.0	92.2
Feces	1466.6	1353.3	113.3	126.7	493.2	689.2	44.2
Digested	1338.6	1279.5	59.1	176.3	385.4	669.8	48.0
Per cent digested	47.7	48.5	34.3	58.2	43.9	49.3	52.1
SHEEP II.							
Oat hay (cut when in milk)	1468.2	1376.7	91.5	155.4	463.0	710.6	47.7
Feces	694.5	641.8	52.7	62.3	235.3	327.7	16.5
Digested	773.7	734.9	38.8	93.1	227.7	382.9	31.2
Per cent digested	52.7	53.3	42.4	59.9	49.2	53.9	65.4
SHEEP III.							
Oat hay (cut when in milk)	2936.4	2753.4	183.0	310.7	926.0	1421.2	95.5
Feces	1431.4	1297.3	134.1	128.8	500.0	637.1	31.4
Digested	1505.0	1456.1	48.9	181.9	426.0	784.1	64.1
Per cent digested	51.2	52.8	26.7	58.5	46.0	55.1	67.1
SHEEP IV.							
Oat hay (cut when in milk)	1226.2	1154.3	71.9	141.2	375.6	595.9	41.6
Feces	493.8	445.5	48.3	59.8	143.0	228.0	14.7
Digested	732.4	708.8	23.6	81.4	232.6	367.9	26.9
Per cent digested	59.7	61.4	32.9	57.7	61.9	61.7	64.7
Average	52.8	54.0	34.1	58.6	50.3	55.0	62.3

FUEL VALUE OF FOOD FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	12795	6937	5808	153.4	5961.4	46.6
Sheep II	6696	3360	3336	81.0	3417.0	51.0
Sheep III	13393	6625	6768	158.3	6926.3	51.7
Sheep IV	5593	2353	3240	70.8	3310.8	59.2

DIGESTION EXPERIMENT 65—(OAT HAY CUT IN DOUGH.)

RATIONS FED.

Fed daily, Sheep I, 600 grams per day.
Fed daily, Sheep II, 400 grams per day.
Fed daily, Sheep III, 600 grams per day.
Fed daily, Sheep IV, 400 grams per day.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDER.		%	%	%	%	%	%	%	
Oat hay (cut when in dough)	4089	83.70	93.77	6.23	7.73	31.74	50.91	3.39	4541
FECES.									
Sheep I	4091	-	91.85	8.15	9.39	34.45	45.54	2.47	4643
Sheep II	4092	-	93.50	6.50	8.36	35.77	46.43	2.94	4850
Sheep III	4093	-	91.43	8.57	8.69	35.23	45.29	2.21	4654
Sheep IV	4094	-	91.84	8.16	12.05	31.01	45.40	3.38	4859

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Oat hay (cut when in dough)	2304.7	2162.1	142.6	184.8	711.1	1184.1	82.1
Feces	1080.4	992.4	88.0	101.5	372.3	492.0	26.6
Digested	1224.3	1169.7	54.6	83.3	338.8	692.1	55.5
Per cent digested	53.1	54.1	38.3	45.1	47.6	58.4	67.6
SHEEP II.							
Oat hay (cut when in dough)	1559.5	1463.2	96.3	124.4	483.8	800.1	54.9
Feces	674.1	630.3	43.8	56.3	241.2	313.0	19.8
Digested	885.4	832.9	52.5	68.1	242.6	487.1	35.1
Per cent digested	56.1	56.9	54.5	54.7	50.2	60.9	63.9
SHEEP III.							
Oat hay (cut when in dough)	2511.0	2354.5	156.5	194.0	797.0	1278.5	85.0
Feces	1225.4	1120.3	105.1	106.5	431.7	555.0	27.1
Digested	1285.6	1234.2	51.4	87.5	365.3	723.5	57.9
Per cent digested	51.1	52.4	32.8	45.1	45.8	56.6	68.1
SHEEP IV.							
Oat hay (cut when in dough)	1457.1	1367.7	89.4	119.9	441.1	753.2	53.5
Feces	657.2	603.6	53.6	79.2	203.8	298.4	22.2
Digested	799.9	764.1	35.8	40.7	237.3	454.8	31.3
Per cent digested	54.8	55.8	40.0	33.9	53.8	60.4	58.5
Average	53.8	54.8	41.4	44.7	49.4	59.1	64.5

FUEL VALUE OF FOOD FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food eaten.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	10466	5016	5450	72.5	5522.5	52.7
Sheep II	7082	3269	3813	59.2	3872.2	54.7
Sheep III	11402	5703	5699	76.1	5775.1	50.6
Sheep IV	6617	3193	3424	35.4	3459.4	52.2

DIGESTION EXPERIMENT 66—(OAT HAY PARTLY IN BLOOM, PARTLY IN MILK.)

RATIONS.

Fed daily, Sheep I, 600 grams per day.
Fed daily, Sheep III, 600 grams per day.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free. Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDER.		%	%	%	%	%	%	%	
Oat hay (just coming ing into milk)......	4127	86.24	92.66	7.34	10.20	33.48	45.66	3.32	4535
FECES.									
Sheep I..............	4128	–	89.95	10.05	7.95	34.95	44.10	2.95	4611
Sheep III.............	4129	–	89.33	10.67	8.89	34.06	43.80	2.58	4655

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PER CENT DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Oat hay (just coming into milk)...........	2587.2	2397.3	189.9	263.9	866.2	1181.5	85.9
Feces....................	1132.3	1018.5	113.8	90.1	395.7	499.3	33.4
Amount digested......	1454.9	1378.8	76.1	173.8	470.5	682.0	52.5
Per cent digested.....	56.2	57.5	40.1	65.9	54.3	57.7	61.1
SHEEP III.							
Oat hay (just coming into milk)...........	2587.2	2397.3	189.9	263.9	866.2	1181.3	85.9
Feces....................	1151.5	1028.7	122.9	102.4	392.2	504.3	29.7
Amount digested......	1435.7	1368.6	67.0	161.5	474.0	677.0	56.2
Per cent digested......	55.5	57.1	35.3	61.2	54.7	57.3	65.4
Average...........	55.9	57.3	37.7	63.6	54.5	57.5	63.3

FUEL VALUE FOR FOUR DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total available fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	%
Sheep I	11733	5221	6512	151.2	6663.2	56.79
Sheep III.	11733	5360	6373	140.5	6513.5	55.51

DIGESTION EXPERIMENT 67—(OAT HAY, PARTLY IN MILK, AND PARTLY IN DOUGH.)

RATIONS.

Fed daily, Sheep I, 600 grams per day.
Fed daily, Sheep III, 600 grams per day.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen—free extract.	Fat.	Calories per gram.
FODDER.		%	%	%	%	%	%	%	
Oat hay (just coming into dough stage)..	4130	86.72	92.79	7.21	7.60	33.96	47.42	3.81	4649
FECES.									
Sheep I.	4131	–	90.00	10.00	8.82	35.96	42.86	2.36	4587
Sheep II.............	4132	–	90.09	9.91	8.97	36.17	42.48	2.47	4613

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PER CENT DIGESTED.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Oat hay (just coming into dough stage)....	2601.6	2414.0	187.6	197.7	883.5	1233.7	99.1
Feces	1197.2	1077.5	119.7	105.6	430.5	513.1	28.3
Digested	1404.4	1336.5	67.9	92.1	453.0	720.6	70.8
Per cent digested......	54.0	55.4	36.2	46.5	51.3	58.4	71.4
SHEEP III.							
Oat hay (just coming into dough stage)....	2601.6	2414.0	187.6	197.7	883.5	1233.7	99.1
Feces..................	1133.2	1020.9	112.3	101.6	409.9	481.4	28.0
Digested................	1468.4	1393.1	75.3	96.1	473.6	752.3	71.1
Per cent digested......	56.4	57.7	40.1	48.6	53.6	61.0	71.7
Average	55.2	56.6	38.2	47.6	52.5	59.7	71.6

FUEL VALUE FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total fuel value.	Per cent available fuel value.
Sheep I	12095	5492	6603	80.1	6683.1	55.25
Sheep III	12095	5227	6868	83.6	6951.6	57.47

DIGESTION EXPERIMENT 68—(H-O HORSE FEED.)

This feed was fed without hay or other coarse fodder, which is a somewhat unusual thing to do with so concentrated a feed. It was not analyzed before the experiment was made as its composition was supposed to be about the same as that of a sample previously analyzed, but it proved to be considerably richer. The sheep were quite large and strong, however, and stood the ration very well, only one refusing to eat all that was given him.

RATIONS.

Fed daily, Sheep II, 800 grams per day.
Fed daily, Sheep III, 800 grams per day.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free.			
			Organic matter.	Protein.	Nitrogen-free extract.	Fat.
FODDERS.		%	%	%	%	%
H-O Horse Feed	4080	88.94	96.36	15.11	65.84	4.39
FECES.						
Sheep II	4087	–	86.90	18.96	44.62	4.92
Sheep III	4088	–	90.67	11.62	48.01	2.33

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED IN FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Protein.	Nitrogen-free extract.	Fat.
SHEEP II.	Grams.	Grams.	Grams.	Grams.	Grams.
H-O Horse Feed	3201.8	3085.3	483.8	2108.1	140.6
Feces	748.2	650.2	141.9	333.8	36.8
Digested	2453.6	2435.1	341.9	1774.3	103.8
Per cent digested	76.6	78.9	70.7	84.3	73.9
SHEEP III.					
H-O Horse Feed	3557.6	3428.2	537.6	2342.3	156.2
Feces	897.5	813.8	104.3	430.9	20.9
Digested	2660.1	2614.4	433.3	1911.4	135.3
Per cent digested	74.8	76.3	80.6	81.6	86.6
Average	75.7	77.6	75.7	83.0	80.3

DIGESTION EXPERIMENT 69—(FLAX MEAL FED WITH OAT HAY.)

RATIONS.

Fed daily, Sheep I, Oat hay, 400 grams; Flax meal 200 grams.
Fed daily, Sheep II, Oat hay, 400 grams; Flax meal 200 grams.
Fed daily, Sheep III, Oat hay, 400 grams; Flax meal 200 grams.
Fed daily, Sheep IV, Oat hay, 200 grams; Flax meal 200 grams.

COMPOSITION OF FODDERS AND FECES.

	Laboratory number.	Dry matter.	Water-free.						
			Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Calories per gram.
FODDERS.		%	%	%	%	%	%	%	
Oat hay (cut when in milk)	4096	73.41	93.77	6.23	10.58	31.53	48.41	3.25	4561
Cleveland Flax Meal	4108	91.17	94.07	5.93	44.15	7.97	36.92	5.03	4791
FECES.									
Sheep I	4112	–	90.12	9.88	15.19	32.63	40.43	1.87	4589
Sheep II	4113	–	92.85	7.15	12.48	34.09	44.09	2.19	4780
Sheep III	4114	–	90.46	9.54	17.99	29.79	40.37	2.31	4661
Sheep IV	4115	–	85.44	14.56	19.62	22.73	39.98	3.11	4520

TOTAL NUTRIENTS IN FOOD EATEN AND FECES EXCRETED FOR FIVE DAYS AND PERCENTAGES DIGESTED.

	Dry substance.	Organic matter.	Protein.	Nitrogen-free extract.	Fat.
SHEEP I.	Grams.	Grams.	Grams.	Grams.	Grams.
Fed in hay	1468.2	1376.7	155.4	710.6	47.7
Fed in flax meal	911.7	857.6	402.5	336.6	45.8
Total fed	2379.9	2234.3	557.9	1047.2	93.5
Total feces	984.5	887.2	149.5	398.1	18.4
Total digested	1395.4	1347.1	408.4	649.1	75.1
Digested from hay	700.3	668.9	90.4	350.3	24.9
Digested from flax meal	695.1	678.2	318.0	298.8	50.2
Per cent digested from flax meal	76.2	79.1	79.0	88.8	109.6
SHEEP II.					
Fed in hay	1468.2	1376.7	155.4	710.6	47.7
Fed in flax meal	911.7	857.6	402.5	336.6	45.8
Total fed	2379.9	2234.3	557.9	1047.2	93.5
Total feces	802.0	744.6	100.1	353.5	17.6
Total digested	1577.9	1489.7	457.8	693.7	75.9
Digested from hay	773.7	734.9	93.1	382.9	31.2
Digested from flax meal	804.2	754.8	364.7	310.8	44.7
Per cent digested from flax meal	88.2	88.0	90.6	92.3	97.6
SHEEP III.					
Fed in hay	1468.2	1376.7	155.4	710.6	47.7
Fed in flax meal	911.7	857.6	402.5	336.6	45.8
Total fed	2379.9	2234.3	557.9	1047.2	93.5
Total feces	904.2	817.9	162.7	365.0	20.9
Total digested	1475.7	1416.4	395.2	682.2	72.6
Digested from hay	751.8	727.4	90.9	391.5	32.0
Digested from flax meal	723.9	689.0	304.3	290.7	40.6
Per cent digested from flax meal	79.3	80.3	75.6	86.4	88.6
SHEEP IV.					
Fed in hay	734.1	688.4	77.7	355.3	23.8
Fed in flax meal	911.7	857.6	402.5	336.6	45.8
Total fed	1645.8	1546.0	480.2	691.9	69.6
Total feces	490.1	418.7	96.2	195.9	15.2
Total digested	1155.7	1127.3	384.0	496.0	54.4
Digested from hay	438.3	423.2	44.9	219.4	15.4
Digested from flax meal	717.4	704.1	339.1	276.6	39.0
Per cent digested from flax meal	78.7	82.1	84.2	82.2	85.2
Average	80.6	82.4	82.4	87.4	95.3

FUEL VALUE FOR FIVE DAYS AS DETERMINED BY THE BOMB CALORIMETER.

	Fuel value of food.	Fuel value of feces.	Fuel value of food digested.	Fuel value of urea, etc.	Total fuel value.	Per cent available fuel value.
	Calories.	Calories.	Calories.	Calories.	Calories.	
Sheep I	11064	4518	6546	355.3	6901.3	62.37
Sheep II	11064	3833	7231	398.3	7629.3	68.95
Sheep III	11064	4215	6849	343.8	7192.8	65.01
Sheep IV	7716	2215	5501	334.0	5835.0	75.62

SUMMARY OF DIGESTION COEFFICIENTS OBTAINED IN THE EXPERIMENTS HERE REPORTED.*

	Number of experiment.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%	%	%
Oat hay: cut in bloom	63	54.3	53.7	48.6	53.5	59.9	51.2	48.3
Oat hay: cut in milk	64	52.8	54.0	34.1	58.6	50.3	55.0	62.3
Oat hay: cut in dough	65	53.8	54.8	41.0	44.7	49.4	59.1	64.5
Oat hay: cut in bloom and milk	66	55.9	57.3	37.7	63.6	54.5	57.5	63.3
Oat hay: cut in milk and dough	67	55.2	56.6	38.2	47.6	52.5	59.7	71.6
H-O Co.'s Horse Feed	68	75.7	77.6	-	75.7	-	83.0	80.3
Flax meal	69	80.6	82.4	-	82.4	-	87.4	95.3

*On pages 156 to 158 of the Report of this Station for 1897 there are given the results of all digestion experiments with sheep made at the Station up to that time.

OAT HAY HARVESTED AT DIFFERENT STAGES OF MATURITY.

J. M. Bartlett.

It is quite a common practice with many farmers to harvest oats before the grain is mature and cure them for coarse fodder. This is a very desirable plan to follow at times when the hay crop is short, or in localities where the land is badly infested with noxious weeds like the Canada thistle or wild mustard, both of which should be cut before they seed.

The oat plant, however, is not an ideal one for making hay. The stalks are hollow, coarse and hard, and unless dried very quickly in a bright sun they become bleached, even when cut green, so that they look little better than straw. To cure the crop in its best condition and retain its bright green color and palatability, it should be dried in a bright sun for a few hours, with liberal use of the hay tedder when there is a heavy growth; then raked together and the curing completed in the windrow or cock, with as little exposure to moisture as possible. If the weather is unfavorable, as is frequently the case during the latter part of July or first of August when oats are mature enough to cut for hay, they are very liable to be seriously injured and rendered unpalatable. They have not proved a good crop for ensiling, not keeping nearly as well as corn or many other crops, therefore the silo cannot be offered as a means of curing in bad weather. Oats, however, when not sown too thickly, have an advantage over other plants, which make more desirable hay, of being a fairly good catch crop for seeding to grass, as they mature early enough to allow the young grass to get a good start in the fall, and for this reason are desirable on the farm.

It is quite well known, and there is considerable experimental data showing that most plants like the grasses, clovers, etc., usually grown for hay are at their best to harvest when in bloom, but

as regards oats there is very little available information indicating at what stage of growth they should be cut for hay making.

Accordingly some experiments were undertaken to determine the comparative value of oat hay cut at different stages of maturity. In 1897 a section of a field of oats was set apart for these tests. The portion selected was covered with a fairly uniform growth and the oats in all parts of it appeared at about the same stage of maturity. The piece was then divided into three equal sections. One of these sections was cut on July 27th when the oats were in bloom. A second section was cut one week later, August 5th, when nearly all the kernels were in the milk stage, and the third August 12th when nearly all the grains had passed to the dough stage of maturity, the tops and upper portion of the stalks were green, but the lower portions showed signs of ripening. When cured this cutting made nearly as good looking hay as the other two sections, but evidently was not as palatable as it was not as readily eaten by the sheep. Care was taken in curing all the cuttings to avoid exposure to moisture, all were dried as quickly as possible and then stored in the barn until needed for further work.

To estimate the increased yield from the growth of the crop during the time that elapsed between the cuttings, three sections, each 10 x 15 feet, were taken in different parts of the large plats. One third, five feet of the length, was cut each time that cuttings were made from the larger sections, carefully dried and the dry matter determined in each, which is given in pounds per acre.

Dry matter of 1st cutting per acre,	4418.8 pounds.
Dry matter of 2d cutting per acre,	5218.3 pounds.
Dry matter of 3d cutting per acre,	4571.0 pounds.

The third cutting was worked on somewhat by birds, which probably accounts for the decrease in yield below the second.

The composition of the hays cut at different stages of maturity is shown in the table which follows. Another table also shows the composition of three different sections of the oat plant, the object being to determine at what distance from the ground the oats should be cut, or what loss occurred by leaving a long stubble. Some plants 3½ to 4 feet high were cut close to the ground; then divided into three sections, one of which was

the first eight inches of the lower part of the stalk, another the second eight inches, and the third, the remainder of the plant or top. An inspection of the table shows a marked difference in composition of the different sections. The bottom section has very little food value, containing only 2.77% protein and 1.90% fat, both of which are probably not more than 40% digestible. The second section has only about half the protein of the top section and its digestibility is probably less. It would, therefore, be advisable to leave a high stubble, not less than eight to ten inches of plants 3 to 4 feet high in harvesting, and the loss incurred will be more than compensated by the improved quality and palatability of the hay by leaving the coarser part of the stalks on the ground.

COMPOSITION OF THE WATER-FREE OAT HAYS.

	Laboratory number.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
		%	%	%	%	%
Oat hay: cut when grain was in dough ...	4089	6.23	7.73	31.74	50.91	3.39
Oat hay: cut when grain was in milk	4096	6.23	10.58	31.53	48.41	3.25
Oat hay: cut when in bloom	4097	7.55	9.86	36.70	43.38	2.51
Oat hay: cut when just beginning to come into milk	4127	7.34	10.20	33.48	45.66	3.32
Oat hay: cut when part of the kernel had passed to dough stage	4130	7.21	7.60	33.96	47.42	3.81
Oat hay: first 8-inch section of bottom of stalk	4134	6.84	2.77	43.49	45.00	1.90
Oat hay: second 8-inch section of stalk...	4135	8.16	4.79	41.60	43.23	2.22
Oat hay: top of plant	4133	7.01	9.62	27.83	51.75	3.79

AMOUNT OF DIGESTIBLE NUTRIENTS IN 100 POUNDS OF WATER-FREE OAT HAY CUT AT DIFFERENT STAGES OF MATURITY.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%	%	%	%
Oat hay: in bloom..................	40.77	49.65	3.67	5.28	21.98	22.21	1.21
Oat hay: in milk....................	38.76	50.64	2.13	6.20	15.86	26.63	2.02
Oat hay: in dough..................	45.03	51.39	2.58	3.46	15.67	30.08	2.19
Oat hay: just coming into milk ...	48.21	53.10	2.77	6.49	18.24	26.26	2.10
Oat hay: just coming into dough stage	47.87	52.51	2.76	3.62	17.83	28.32	2.73

THE EFFECT OF FOOD ON THE HARDNESS OF BUTTER AND COMPOSITION OF BUTTER FAT.

J. M. Bartlett.

The primary object of the experiments presented in the following pages was to study the effect of gluten meals, varying greatly in fat content, on the texture of butter and composition of butter fat produced by cows receiving quite liberal quantities of these materials. Eight different meals which contained from 1% to 19% fat were used in as many different feeding trials, also Buffalo gluten feeds and flax meal were each fed during one experiment and cottonseed meal during three.

A total of eleven cows were used in the experiments, and in all, twelve tests were made. The work was begun in the winter of 1896-97 and again taken up during the winters of 1897-98 and 1898-99.

In the third or last experiment the effect of the fat of the food on the fat content of the milk was given some attention. A detailed account of the work is given in the pages which follow.

Considerable work has already been done by investigators both in this country and Europe, showing that the texture or hardness of butter and composition of the butter fat is influenced very markedly by the food of the animal.

Some years ago quite extensive experiments were made at the Texas Experiment Station in feeding cottonseed and its meals to learn their effect on the fat of the milk produced. The results showed that large rations of these materials produced very hard butters, the fats of some of them having a melting point above 40° C. with very low volatile acids and iodine numbers. At the New Hampshire Experiment Station* some work was done showing that the gluten meals produced softer butters

* Bulletin No. 13.

than corn or cottonseed meals, and the fats of these soft butters had higher iodine absorption power, indicating a change in their chemical composition. Also at the same Station† it was shown that when oils were fed the butter fat produced varied its composition in most cases in accordance with the composition of the fat fed.

The Vermont Experiment Station‡ found that a gluten meal having about 12% fat made a softer butter fat with lower melting point and a higher iodine number than other rations consisting of corn meal and bran, or of cottonseed meal, corn meal and bran.

Spier§ observed, in his extensive feeding experiments, that the different concentrated feeds affected the melting point of the butter very materially. He obtained the firmest butter with the highest melting point when decorticated cottonseed cake was fed, and attributes the cause to the highly nitrogenous ration used.

A. Mayer** states in his account of extensive investigations in feeding cows that the hardness of butter is considerably affected by the food.

Practical dairymen have long been aware of the fact that certain concentrated feeds when liberally used in rations for milch cows, have a very decided effect on the texture or grain of the butter. Cottonseed meal is very generally known to produce hard butter, while the gluten meals are equally well known to produce soft butter. Corn meal has always been used to some extent by farmers who have practiced feeding grain and is known to make excellent butter of about the desired degree of hardness, and the glutens which are a by-product from the manufacture of glucose or starch from corn, and therefore, a corn product, would be expected to make butter having like characteristics. In practice, however, they have been found to have a very different effect and the reputation of the gluten products for making soft butter has become so well established that in some sections of the State butter factories have refused to accept cream from parties who were feeding them. Among private dairymen the opinion very generally prevails that these feeds are not desirable for use, especially in warm weather. On

† Bulletin No. 16. ‡ Report of the Vermont Experiment Station 1897.
§ Transactions of the Highland Agricultural Society, Scotland, 1897.
** Landw. Vers. Stat. 41, pp. 14-35.

the other hand, cottonseed meal was known to make a hard butter, and when fed in moderate quantities with corn meal and bran, produced an article of the best quality. Consequently, cottonseed meal became a popular feed as a source of protein, almost to the exclusion of the gluten meals among farmers who were feeding for butter production. But in the fall and early winter of 1896 and 1897 the gluten meals were offered in our markets at very low prices furnishing, thereby, protein more cheaply than any other concentrated feed. For this reason it was desirable that farmers use these feeds to the largest possible extent. In view of this fact it was considered advisable to investigate the cause of the unfavorable action of these products and determine, if possible, a way to eliminate it either through the method of manufacturing or feeding them.

A comparison of the composition of the gluten meals with corn meal showed that the chief variations were in the protein and fat content. The percentages of these substances being much higher in the gluten than in the corn meal, this fact, together with the work done by Morse†† in feeding oil to cows, led us to believe that the oil of the gluten products was the disturbing element. Accordingly some feeding experiments were begun in the winter of 1896-7 to test the following points, viz.: If the high oil content of the glutens caused them to make soft butters, and if so, to what extent they should be freed from it to remedy the difficulty.

EXPERIMENT I.

In this experiment, the feeding trials were divided into periods of two weeks each, which is a shorter time for feeding tests than is generally desirable, but as the only object in this experiment was to test the effect of the feed on the composition of the butter fat, the length of time employed was considered sufficient.

At this time there was offered in the market two kinds of gluten meals, one being rich in fat, containing from 15% to 20% and another containing from 7% to 10% fat. These meals varied sufficiently in their fat content to be desirable for use in this experiment, especially as the one richer in fat was poorer in protein, making it necessary to greatly increase the fat in one

†† N. H. Station Bulletin 16.

ration over that in the other to get the required amount of protein.

Three good Jersey cows quite fresh in milk were used, and it will be seen that they were fed a cottonseed meal ration in the first and fourth periods; the object being to test their ability to make good butter in the first period and the effect of the advance in time of lactation in the fourth period.

DAILY RATION FOR EACH ANIMAL.

Basal ration of, hay, 10 pounds, silage, 25 pounds.

Period I. Eight pounds grain mixture: 3 parts cottonseed meal; 2 parts wheat bran; 3 parts corn meal.

Period II. Eight pounds grain mixture: 9 parts Chicago gluten meal; 4 parts wheat bran; 3 parts corn meal.

Period III. Eight pounds grain mixture: 3 parts King gluten meal; 1 part wheat bran.

Period IV. Eight pounds grain mixture. Same as period I.

DIGESTION COEFFICIENTS USED IN CALCULATING THE DIGESTIBLE NUTRIENTS IN THE EXPERIMENTS HERE REPORTED.

	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%
Hay	44	52.5	62	39
Silage	56	72	76	73
Cottonseed meal	88	-	64	97
Gluten meals	87	-	91	88
Gluten feed	85	43	81	81
Flax meal	82.4	-	87.4	95.3
Corn meal	77	-	92	92
Wheat bran	78	25	68	72

COMPOSITION FODDERS AND FEEDS USED.

	Station number.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Hay	4061	16.50	4.92	7.91	26.57	42.33	1.77
Silage	4048	81.43	1.28	1.85	4.92	9.97	0.55
Cottonseed meal	4013	7.46	5.63	50.31	4.40	21.24	10.96
Wheat bran	4015	9.83	5.47	16.31	8.93	53.96	5.50
Corn meal	4014	12.40	1.47	10.63	2.33	69.04	4.13
Chicago gluten meal	4016	10.11	1.38	36.00	3.86	40.49	8.16
King gluten meal	4018	9.53	1.94	26.31	2.45	44.59	15.18

DIGESTIBLE NUTRIENTS EATEN DAILY IN EACH RATION.

	Protein —pounds.	Carbohydrates —pounds.	Fat —pounds.	Nutritive ratio.
Period I.				
Grain mixture	1.88	2.85	.52	
Hay	.35	4.03	.07	
Silage	.26	2.77	.10	
Total	2.49	9.65	.69	1:4.50
Period II.				
Grain mixture	1.72	3.38	.46	
Hay	.35	4.03	.07	
Silage	.26	2.77	.10	
Total	2.33	10.18	.63	1:4.98
Period III.				
Grain mixture	1.61	3.30	.88	
Hay	.35	4.03	.07	
Silage	.26	2.77	.10	
Total	2.22	10.10	1.05	1:5.61
Period IV.				
Grain mixture	1.88	2.85	.52	
Hay	.35	4.03	.07	
Silage	.26	2.77	.10	
Total	2.49	9.65	.69	1:4.50

COMPOSITION OF THE BUTTERS AND BUTTER FATS.

	Butter.				Butter Fat.		
	Water.	Ash.	Casein.	Fat.	Melting point.	Iodine number.	Volatile acids.
Period I—Cottonseed meal ration.	12.65	1.51	1.10	84.75	35.1	27.65	30.39
Period II—Chicago gluten meal ration	13.00	3.81	1.33	81.85	33.3	29.88	30.72
Period III—King gluten meal ration	12.76	4.22	1.30	81.73	32.5	37.2	32.5
Period IV—Cottonseed meal ration	–	–	–	–	35.1	25.9	31.9

EXPERIMENT II.

To further test the effect of food on the hardness of butter and composition of the butter fat, with other cows than those used in Experiment I and for longer feeding periods, a second experiment was undertaken in the winter of 1897-1898. The time covered by this test was divided into five feeding periods of twenty-one days each, with one transition week between each period for changing the ration. In the first trial a cottonseed meal ration was used to test the capacity of the cows, as in the first experiment. In the second period the cottonseed meal was replaced by flax meal, one of the linseed products, which contains a small per cent of fat as compared with the old process linseed meal, that always bore the reputation of making soft butter. The object of this test was to learn if a more complete removal of the fat corrected that tendency. During the experiment a daily record of the milk yield was kept and the milk of the last five days of each period was analyzed. The results of the experiment are given in the following tables:

Cows used (registered Jerseys):

Addie, fresh in milk, October 8, 1897; Hope, fresh in milk, October 28, 1897; Loblitop, fresh in milk, October 14, 1897; Rose, fresh in milk, November 16, 1897.

DAILY RATIONS FOR EACH ANIMAL.

Basal ration: hay, 15 pounds; silage, 15 pounds; same for each period.

Period I. Grain, 8 pounds of mixture of: 2 parts cottonseed meal; 2 parts wheat bran; 3 parts corn meal.

Period II. Grain, 8 pounds of mixture of: 2 parts flax meal; 1 part wheat bran; 2 parts corn meal.

Period III. Grain, 8 pounds of mixture of: 3 parts Chicago gluten meal; 2 parts wheat bran; 2 parts corn meal.

Period IV. Grain, 8 pounds of mixture of: 5 parts gluten feed; 1 part wheat bran; 2 parts corn meal.

Period V. Grain, 8 pounds of mixture of: 5 parts King gluten meal; 4 parts wheat bran; 3 parts corn meal.

COMPOSITION OF FODDERS AND FEEDS USED.

	Station number.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Hay	4121	10.12	5.17	8.19	26.79	47.39	2.34
Silage	4125	87.62	.98	1.50	3.56	5.90	.44
Cottonseed meal	4083	5.27	5.49	52.25	3.81	21.08	12.10
Corn meal	4082	9.92	1.51	10.50	2.08	71.88	4.11
Wheat bran	4081	8.15	5.38	16.94	7.38	57.80	4.35
Flax meal	4108	8.83	5.41	40.25	7.27	33.66	4.58
Chicago gluten meal	4041	5.55	1.21	37.50	2.83	43.98	8.93
Gluten feed	4095	9 32	3.53	27.25	6.69	50.10	3.11
King gluten meal	4140	6.72	1.81	35.94	2.36	35.45	17.72

TOTAL DIGESTIBLE NUTRIENTS EATEN DAILY DURING EACH PERIOD.

	Protein —pounds.	Carbohydrates —pounds. Fiber and nitrogen-free extract.	Fat —pounds.	Nutritive ratio.
Period I.				
From grain ration	1.63	3.52	.47	
From hay	.55	6.54	.14	
From silage	.13	1.05	.05	
Total	2.31	11.11	.66	1:5.45
Period II.				
From grain ration	1.57	3.73	.31	
From hay	.55	6.54	.14	
From silage	.13	1.05	.05	
Total	2.25	11.32	.50	1:5.49
Period III.				
From grain ration	1.61	3.82	.43	
From hay	.55	6.54	.14	
From silage	.13	1.05	.05	
Total	2.29	11.41	.62	1:5.59
Period IV.				
From grain ration	1.45	3.76	.24	
From hay	.55	6.54	.14	
From silage	.13	1.05	.05	
Total	2.13	11.35	.43	1:5.78
Period V.				
From grain ration	1.55	3.49	.68	
From hay	.55	6.54	.14	
From silage	.13	1.05	.05	
Total	2.23	11.08	.87	1:5.85

COMPOSITION OF MILK, AND AVERAGE DAILY YIELD OF MILK, SOLIDS AND FATS FOR EACH PERIOD.

Period.	Cow.	Solids—per cent.	Fat—per cent.	Milk—pounds.	Solids—pounds.	Fat—pounds.
Period I	Addie	13.58	4.85	21.1	2.86	1.02
	Hope	13.92	5.25	19.9	2.77	1.05
	Loblitop	14.33	4.60	17.3	2.47	.80
	Rose	14.42	4.80	17.9	2.58	.86
Period II	Addie	13.65	4.25	19.9	2.72	.85
	Hope	14.61	4.95	17.8	2.60	.88
	Loblitop	13.91	3.90	17.5	2.43	.68
	Rose	14.17	4.15	16.5	2.34	.69
Period III	Addie	13.54	4.55	19.4	2.63	.88
	Hope	14.61	5.05	17.2	2.51	.87
	Loblitop	14.57	4.50	18.1	2.64	.81
	Rose	14.30	4.65	17.0	2.43	.79
Period IV	Addie	14.0	4.90	16.5	2.31	.81
	Hope	15.68	5.30	15.1	2.37	.80
	Loblitop	14.12	4.60	16.7	2.36	.77
	Rose	15.11	5.10	15.6	2.36	.80
Period V	Hope	15.57	5.5	14.6	2.27	.80
	Loblitop	13.59	4.4	19.1	2.60	.84
	Rose	13.76	4.6	16.5	2.27	.76

COMPOSITION OF BUTTERS AND BUTTER FATS.

	BUTTER.				BUTTER FAT.		
	Water.	Ash.	Casein.	Fat.	Melting point.	Iodine number.	Volatile fatty acids.
Period I—Cottonseed meal ration	14.47	1.74	.84	82.95	35.2	28.07	28.55
Period II—Flax meal ration	13.12	3.01	1.34	82.56	34.4	28.88	27.95
Period III—Chicago gluten meal ration	12.81	2.67	1.29	83.24	32.4	31.2	28.4
Period IV—Gluten feed	14.77	1.93	1.01	82.30	32.85	30.44	27.9
Period V—King gluten meal ration	11.18	3.28	1.30	81.22	32.9	38.4	31.9

EXPERIMENT III.

As the results of the two previous experiments indicated that glutens containing large amounts of fat or oil produced softer butters than those containing smaller amounts, it seemed necessary, in order to make the experiment of practical value, to determine the minimum amount of fat that a gluten could contain

when fed in sufficient quantity to supply the necessary protein for butter production.

Arrangements were made with the Cleveland Linseed Oil Company to extract some gluten meal and reduce the fat content to one per cent or less. About this time the Glucose Sugar Refining Company changed the character of their output, making a gluten meal containing less than three per cent of fat. A stock of this meal was also secured for feeding the herd in 1898, and was liberally fed through the winter and summer vacations when butter was made from the product.

In this experiment Jersey cows which were known to be good butter makers were used. They were more advanced in the period of lactation than the animals previously employed, but as they were all still giving a fairly good flow of milk this did not seem objectionable. The feeding periods were twenty-eight days each and the cream for churning was collected during the third or fourth week.

In the second period, one-half pound of tallow was added to the ration which in other respects was the same as in period I. The object of this was to determine whether it was the quality or quantity of fat that affected the butter. The tallow fed was thoroughly emulsified before giving it to the animals. The emulsification was accomplished in the following manner. The grain ration and tallow for each cow was weighed out. The tallow was then put in a water pail with about three quarts hot water and about a pint of the grain, then a jet of steam under high pressure was introduced which emulsified the fat perfectly in about ten or fifteen minutes. The whole was then mixed with the remainder of the grain and fed when cold. Fed in this manner, with one exception, the cows ate the tallow readily.

In the third period the extracted gluten was replaced by the regular stock gluten and one pound King gluten meal was added to increase the amount of fat or oil from corn. The results of each period are given below.

Cows used (registered Jerseys.)

Adle, fresh in milk, April 26; Buttercup fresh in milk, May; Dudley, fresh in milk, August 7; Pansy, fresh in milk, March 28.

DAILY RATIONS FOR EACH ANIMAL.

Hay, 7 pounds; silage, 25 pounds; same for each period.

Period I. Grain, 7 pounds mixture of: 3 parts extracted gluten meal; 2 parts wheat bran; 2 parts corn meal.

Period II. Grain, same as in period 1+½ pound tallow.

Period III. Grain, 8 pounds: 3 parts Chicago gluten; 2 parts wheat bran; 2 parts corn meal; 1 part King gluten meal.

COMPOSITION OF FODDERS AND FEEDS.

	Station number.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Hay	–	14.3	4.74	9.06	28.19	42.21	1.50
Silage	4138	81.75	.91	1.92	4.70	9.89	.83
Extracted gluten	4126	11.00	1.25	41.44	1.82	43.49	1.00
Corn meal	4136	12.55	1.61	9.63	2.19	69.96	4.06
Wheat bran	4137	10.25	6.82	16.06	9.05	53.04	4.78
Chicago gluten meal	4141	12.94	1.42	40.31	2.00	40.96	2.37
King gluten meal	4140	6.72	1.81	35.94	2.36	35.45	17.72
Tallow	–	–	–	–	–	–	99.99

TOTAL DIGESTIBLE NUTRIENTS EATEN DAILY DURING EACH PERIOD

	Protein—pounds.	Carbohydrates—pounds. Fiber and nitrogen-free extract.	Fat—pounds.	Nutritive ratio.
Period I.				
From grain eaten	1.48	3.26	.17	
From hay	.28	2.87	.04	
From silage	.27	2.72	.15	
Total	2.03	8.85	.36	1:4.75
Period II.				
From grain eaten	1.48	3.26	.67	
From hay	.28	2.87	.04	
From silage	.27	2.72	.15	
Total	2.03	8.85	.86	1:5.31
Period III.				
From grain eaten	1.76	3.49	.36	
From hay	.28	2.87	.04	
From silage	.27	2.72	.15	
Total	2.31	9.08	.55	1:4.45

COMPOSITION OF BUTTER AND BUTTER FAT.

	BUTTER.				BUTTER FAT.		
	Water.	Ash and salt.	Casein.	Fat.	Melting point.	Iodine number.	Volatile acids.
Period I—Extracted gluten ration	9.31	1.71	.68	88.33	33.75	26.71	29.7
Period II—Extracted gluten and tallow	10.93	1.44	.70	86.93	34.2	29.31	33.0
Period III-Chicago gluten and King gluten	12.00	2.85	1.06	84.09	33.1	30.66	29.4

DIGESTIBLE FAT FED DAILY, AND THE EFFECT OF THE DIFFERENT RATIONS ON THE BUTTER AND BUTTER FAT.

The concentrated feeds used in the rations.	Digestible fat from grain fed daily—pounds.	Estimated hardness of butter.*	Melting point of fat.	Iodine number of fat.	Volatile acids 1-10 normal alkali.
Cottonseed meal ration of Period I, Exp't. I	0.52	10	35.1	27.65	30.39
Cottonseed meal ration of Period IV, Exp't I.	0.52	10	35.1	25.9	31.9
Cottonseed meal ration of Period I, Exp't II	0.47	10	35.2	28.07	28.55
Average			32.1	27.2	30.28
Gluten meal, quite rich in fat, Period II, Exp't I	0.46	8	33.3	29.88	30.72
Gluten meal, quite rich in fat, Period III, Exp't II	.43	7½	32.4	31.2	28.4
Average			32.9	30.54	29.56
Gluten meal, very rich in fat, Period III, Exp't I	.88	6	32.5	37.2	32.5
Gluten meal, very rich in fat, Period V, Exp't II	.68	6	32.9	38.4	31.9
Average			32.7	37.8	32.2
Extracted gluten meal, Period I, Exp't III	0.17	9	33.8	26.7	29.7
Extracted gluten meal, with tallow, Period II, Exp't III	0.67	9½	34.2	29.3	33.0
Gluten meal, poor in fat, fed herd	–	9	34.1	–	30.3
Mixed gluten meals, Period III, Exp't III	.55	8	33.1	30.66	29.4
Flax meal, Period II, Exp't II	0.31	9	34.1	28.88	27.95
Gluten feed, Period IV, Exp't II	†0.24	8	32.9	30.44	27.9

*An arbitrary comparative scale, 10 representing the hardest butter and 6 the softest.

†Largely corn oil.

DISCUSSION OF RESULTS.

The results of the three experiments presented in the above table indicate, without question, that the food of a cow does, to some extent, vary the composition of the fat of her milk and thereby influences the texture of her butter.

The work of Morse and others led the writer to assume that the fat or oil of some of the so-called concentrated feeds was the disturbing element, consequently these experiments were planned and carried out particularly to test that phase of the subject, and the evidence here presented seems to support the assumption.

It will be noticed that in making up the daily rations an effort was made to make the digestible protein for each period as nearly the same as possible, the chief variations of the rations being in the fat content of the grain fed.

Before referring to the table, it is necessary to state that we did not find the melting point of the fat as determined by the official method, a true indication of the hardness of the butter. It is true that the fats of very hard butters have high melting points, but the fat of some of the medium hard butters gave melting points practically the same as the softest butters, consequently, for convenience in discussing the results, an arbitrary scale of hardness is used, 10 representing the hardest and 6 the softest butter.

Several attempts were made to find some reliable way of determining the hardness or stability of butter in the laboratory that could be compared with its hardness as determined commercially. Some mechanical means have been recommended such as dropping a weighted glass rod and measuring the degree of penetration in the different butters at the same temperature. This method appears to better show the density or compactness of butter than its ability to stand up at high temperatures. In our trials of it, different prints of the same lot showed as great variations as the different lots. It is impossible for a butter maker to handle butter so nicely as to give it the same degree of compactness each time.

Several methods of determining melting points of the fat were tried but none appeared to be more satisfactory than the official method which was used and no single laboratory test indicated

very closely the true hardness of the fat after it was congealed. It was observed, however, that whenever the melting point of the fat was low and the iodine number high, the butter was soft, also that when the conditions were reversed, the melting point high and the iodine number low the butter was hard; and in all cases when the iodine number was low, 30 or less, the hardness of the butter corresponded very closely to the melting point of the fat.

A study of all available results of work by other chemists gives still further encouragement that possibly these two determinations together can be relied upon to indicate the texture.

The manner of determining hardness employed in these experiments cannot be called strictly scientific, but it is believed that the figures given show more nearly the comparative hardness, than any single chemical method employed.

The figures given were obtained by thoroughly testing the butter in a practical way. All the samples were carefully examined by means of pressure, cutting, etc., to determine their hardness at temperatures ranging from 15° C. up to 25° C.; also the butter fats were placed side by side and tested in the same manner, as they seemed to correspond very closely to the butter in hardness. The opinion of the butter maker, on each lot as it was manufactured, was also noted and taken into consideration in making up the scale of figures.

We find by inspection of the table that the average melting point of the fats of the butters marked 6 in hardness is very nearly the same as the fats of those marked 7 and 8 when, as a matter of fact, the butters were so soft that they could hardly be handled at ordinary temperature, and the fats were somewhat liquid at a room temperature of 23° C. while the fats of those marked 7 and 8 were quite hard at the same temperature.

In manufacturing the butters every precaution was taken to avoid variations in hardness, that could arise from physical and mechanical causes by faulty manipulation. The method of manufacture was as uniform as possible for all the periods, and it is difficult to see how the variations in hardness could arise from other than changes in the composition of the butter fat. In fact some of the softest butters contained less water than the hardest ones.

The cream was raised by the Cooley process, then evenly ripened and churned at a uniform temperature of 60° F. All of this part of the work was done under the supervision and skillful management of Prof. Gowell.

In studying the results given in the table, we find that the gluten meals containing the most fat produced the softest butters in every instance, and that the butter produced by these meals increased in hardness in proportion as the glutens decreased in fat content, or in other words, a ration containing six to eight-tenths of a pound of corn oil produced a very soft butter while one containing two to three-tenths made a medium butter, and one with less than one-tenth a fairly hard butter. A chemical examination of the butter fats shows quite a difference in their composition; the most marked difference being shown in the iodine number, which is 11 per cent higher when the glutens rich in fat were fed than when the extracted gluten was used. This indicates that when the ration contains large amounts of corn oil, the butter fats were composed more largely of the liquid fats, olein or linolein, which probably accounts for their softer condition. In these particular cases it appears reasonable to assume that the soft oils of the gluten meals caused the changes in the butter fat.

The basal ration of the different periods was practically the same. The amount of digestible protein fed in period III, experiment I, and period V, experiment II, when the softest butters were made, was greater than that of period I of experiment IV, when the extracted gluten was used and made butter of normal firmness. Consequently the soft butter cannot be attributed to the non-nitrogenous character of the ration, and neither could it to the excess of fat alone but to its character, for in period II of experiment III, when one-half pound of tallow was added to the ration, the butter became harder and the melting point of the butter fat increased, showing that in some way, either directly or indirectly, the properties of the fat of the food are transmitted to the fat of the milk.

Morse arrived at the same conclusions in his experiments in feeding oils. Baumert and Falke† found that feeding certain

* New Hampshire Experiment Station Bul. 16.

† Zeit. für Untersuch. der Nahr. und Genussmittel, 1898, 665-678.

oils very decidedly affected the melting point of butter fat while others were without much effect. Sesame oil produced a butter fat with a high melting point and almond and cocoanut oils had very little effect on the product which had a normal melting point. Spier, in discussing his work of feeding milch cows, states that nitrogenous foods such as cottonseed cake produce firm butters with high melting points, while starchy or carbonaceous foods like sugar meal make soft butters. These statements are true as applied to those two materials, but if the hardness of the butter is influenced wholly by the nitrogenous and carbonaceous matter of the rations, then it is difficult to explain why corn meal, a carbonaceous food, will make a harder butter than some gluten and linseed meals that are highly nitrogenous but contain quite large percentages of fat.

Cottonseed meal which invariably produces hard butter is not very different in the food elements it contains from the old process linseed meals and some of the glutens from which the starch has been quite completely removed, and these latter products, when they contain as much fat as cottonseed meals usually do, make soft butters.

A chemical examination of the fats of these three foods may offer a possible explanation. Crude cottonseed oil is found to contain quite a quantity of vegetable stearin, so-called, which is separated from the cotton oil of commerce by cold and pressure and used largely for making lard and butter substitutes. Its fatty acids have a high melting point (38° C.) and its general character is not unlike sesame oil which has been found to produce hard butter when fed to cows. Corn oil on the other hand contains practically no stearin, and according to Hopkins* is about 45 per cent olein and 48 per cent linolein, while linseed oil is 80 per cent linolein. The fatty acids of these two oils are liquid below zero Centigrade; linolein being liquid at—18° C. There seems to be sufficient difference in the character of the fats to account for the changes in the butter if one wishes to attribute the variation to the fat of the food. It is possible, however, that the proteids of the food play an important part in the formation of milk fat and have an important bearing on the hardness of the butter, but it is also evident that the oils of the

*Illinois Station Bulletin 52.

gluten products are detrimental to making good butter, and its firmness is very much decreased by the presence of these oils and increased by their removal.

The new process linseed meal now on the market contains but a small amount of fat and consequently, according to previous reasoning, should make a fairly hard butter. To test the matter a linseed product sold under the name of flax meal was fed in period II, experiment I. The result is given in the table above. During 1898 the whole herd of cows were fed a grain ration consisting of wheat bran, corn meal, and Chicago gluten meal containing 2.87% fat. Enough of this gluten was used to furnish the required amount of protein, and no cottonseed meal was fed. During the winter and summer vacations the product was made into butter of which quite a large part was shipped to Boston and the remainder disposed of in the local markets. The butter was rated as first quality and in no instance was a complaint made of it being soft. The sample marked in the table Herd butter was taken during the early part of September.

CONCLUSIONS.

1st. The hardness of butter can be regulated to a large extent by the food of the cows.

2d. Gluten products such as gluten meal, feeds, etc., containing large percentages of oil produce soft butter and should not be fed to dairy cows used for butter production.

3d. Gluten meals containing small percentages of fats, 3% or less, and high percentages of protein, when fed in combination with corn meal and bran, will make butter sufficiently hard for this climate.

4th. The glutens, however, if freed from fat will not produce butter of more than normal hardness and do not have the hardening effect of cottonseed meals; when a very hard butter is desired some cottonseed meal should be fed.

THE EFFECT OF FEEDING FAT ON THE FAT CONTENT OF THE MILK.

J. M. Bartlett.

The preceding experiments were not undertaken to test the effect of the fat of the food on the yield of fat in the milk. In the first two experiments (see pages 99 to 105) the feeding periods were not long enough and the milk was not tested often enough to give reliable data on this point. In experiment III, (see pages 105 to 108) however, the feeding periods were longer, being for the most part 28 days. A composite sample of the milk of each cow taken during the last four days of each week was tested and had it not been for the misfortune of having part of the records of the milk yield destroyed, we would have had considerable reliable data bearing on the subject. A number of attempts have been made in this country, also in Europe, to feed fat into milk, but with a few exceptions the experimenters have arrived at the same conclusion, viz., that the per cent of fat in the milk depends on the individuality of the cow, and can only be slightly or temporarily varied by the food.

Prof. Soxhlet * in 1896 made some experiments in which he claims to have materially increased the fat in milk of cows by feeding them oil in the form of an emulsion. The oil was emulsified for the purpose of aiding the animals in digesting it. The author believes others have failed to get like results for the reason that the fats have not been fed in digestible forms. He gives very little data as to the details of his experiment and most of the paper is given up to theorizing and discussing the results. In the discussion mention is made of feeding periods of four and eight days, and no further mention of time is made. If such short feeding periods were employed, the results can easily be explained, as nearly every one who has experimented with cows has had like experiences.

* Experiment Station Record (Vol. 8, pp. 1016).

F. Albert * and M. Maercker found that feeding rations rich in fat caused a decided increase in the fat of the milk, but a study of their data shows that their feeding periods were very short, being from 7 to 14 days each. The greatest increase both in the per cent of fat in the milk and total yield obtained with a ration rich in fat over one poor in fat was in a feeding period of only seven days. In another trial when two rations rich in fat followed in succession, making a total of about twenty-four days for the two periods, the average yield of fat fell off in the latter period to about the same as was obtained from the previous ration poor in fat.

The author attributes this loss to an over feeding of fat and makes no account of the cow being allowed sufficient time to accommodate herself to the abnormal ration. He also states that there was a great accumulation of body fat and thinks that possibly the results suggest a means of rapidly fattening a dry cow.

S. Rhodin † reports some results of feeding emulsified oils to cows in feeding periods of three to four weeks duration. The author briefly states in his conclusion that the fat content of the milk was increased at first by feeding oil in the form of an emulsion, but later on no increase took place; the milk on the contrary, dropped to its previous normal fat content.

The results of the experiment, presented in the following tables, are rather meager from which to draw any definite conclusions. They would be more satisfactory if all the records could be given, and the ration rich in fat had been continued through the third period as was planned, but owing to an error on the part of a workman, the fat ration was reduced nearly one-half.

The results are of interest, however, in showing the very decided increase in fat content of the milk for the first two weeks of the period when a ration rich in fat was fed and also the decided drop in the third week. The percentages of fat are lower in the third period than in the second but not materially different from those of the last two weeks of the first period and it is the belief of the writer that they were not decreased by the less amount of fat fed, but by the cows' gradual return to their normal capacity.

* Landw. Jahrb. 27 (1898.). † K. Landt. Akad. Handl., 37 (1888) No. 1, pp. 25–33.

AVERAGE PER CENT OF SOLIDS AND FAT, AND AVERAGE DAILY YIELD OF MILK, SOLIDS AND FAT.

Period I.	Cows.	Solids.	Fat.	Daily yield of milk.	Daily yield of solids.	Daily yield of fat.
		%	%	lbs.	lbs.	lbs.
First week	Adle	–	5.3	16.86	–	.89
	Buttercup	–	6.05	17.06	–	1.03
	Dudley	–	4.4	19.55	–	.86
	Pansy	–	5.6	14.91	–	.84
Second week	Adle	14.46	5.2	16.03	2.32	.83
	Buttercup	14.19	5.75	16.71	2.37	.96
	Dudley	13.06	4.8	19.28	2.52	.93
	Pansy	14.17	5.1	14.60	2.07	.74
Third week	Adle	15.44	6.1	–	–	–
	Buttercup	15.53	6.2	–	–	–
	Dudley	14.31	5.4	–	–	–
	Pansy	15.20	5.0	–	–	–
Fourth week	Adle	15.96	6.35	14.65	2.34	.93
	Buttercup	16.31	6.25	15.47	2.52	.97
	Dudley	14.74	5.15	18.41	2.71	.95
	Pansy	16.10	6.0	13.38	2.14	.80

AVERAGE PER CENT OF SOLIDS AND FAT, AND AVERAGE DAILY YIELD OF MILK, SOLIDS AND FAT.

Period II.	Cows.	Solids.	Fats.	Daily yield of milk.	Daily yield of solids.	Daily yield of fats.
		%	%	lbs.	lbs.	lbs.
First week	Adle	16.33	6.7	–	–	–
	Buttercup	16.28	6.85	–	–	–
	Dudley	14.96	5.8	–	–	–
	Pansy	16.08	6.2	–	–	–
Second week	Adle	16.61	7.1	13.64	2.27	.97
	Buttercup	15.88	6.65	15.60	2.48	1.04
	Dudley	14.45	5.7	18.41	2.66	1.05
	Pansy	15.59	6.25	14.70	2.29	.92
Third week	Adle	16.40	6.7	14.61	2.30	.98
	Buttercup	15.66	6.5	15.87	2.49	1.03
	Dudley	14.51	5.2	19.18	2.78	1.00
	Pansy	15.10	5.8	14.75	2.23	.86
Fourth week	Adle	16.86	6.9	14.58	2.46	1.01
	Buttercup	16.18	6.2	15.80	2.56	.98
	Dudley	15.13	5.55	20.84	3.15	1.16
	Pansy	15.75	5.95	15.54	2.45	.92

AVERAGE PER CENT OF SOLIDS AND FAT, AND AVERAGE DAILY YIELD OF MILK, SOLIDS AND FAT.

Period III.	Cows.	Solids.	Fats.	Daily yield of milk.	Daily yield of solids.	Daily yield of fat.
		%	%	Lbs.	Lbs.	Lbs.
First week	Adle	15.99	6.27	–	–	–
	Buttercup	15.48	5.92	–	–	–
	Dudley	14.44	5.05	–	–	–
	Pansy	14.77	5.32	–	–	–
Second week	Adle	16.94	6.45	–	–	–
	Buttercup	16.13	5.85	–	–	–
	Dudley	14.90	4.95	–	–	–
	Pansy	16.71	5.85	–	–	–
Third week	Adle	16.86	6.15	–	–	–
	Buttercup	15.86	6.35	–	–	–
	Dudley	14.78	5.65	–	–	–
	Pansy	16.03	5.70	–	–	–
Fourth week	Adle	16.69	6.55	–	–	–
	Buttercup	15.36	5.80	–	–	–
	Dudley	15.54	5.40	–	–	–
	Pansy	15.30	5.20	–	–	–

AVERAGE DAILY YIELD OF FAT FOR EACH WEEK PER COW.

	PERIOD I.		PERIOD II.		PERIOD III.	
	Digestible fat fed daily per cow 0.36 pounds.		Digestible fat fed daily per cow 0.86 pounds.		Digestible fat fed daily per cow 0.55 pounds.	
	Fat. Per cent.	Fat. Pounds.	Fat. Per cent.	Fat. Pounds.	Fat. Per cent.	Fat. Pounds.
First week	5.34	0.90	6.39	–	5.64	–
Second week	5.21	0.86	6.43	1.00	5.78	–
Third week	5.66	–	6.05	.97	5.96	–
Fourth week	5.94	0.91	6.15	1.02	5.74	–

INJURIOUS MILLIPEDES.

By F. L. Harvey.

For several seasons, radishes grown in the forcing houses of the Station have been more or less covered with excrescences, rendering them unsightly and unfit for market. From one to six excrescences are often found on a single radish, and five per cent of the crop is sometimes affected. After a careful examination of the beds, the injury has been traced to the biting of the radishes by two species of millipedes, viz.,—*Polydesmus monilaris,* C. L. Koch, and *Iulus hortensis,* Wood. *Both of these species have been caught many times with their mouths on the excrescences in the various stages of their development. Millipedes have been reported as doing injury to the roots of corn and strawberries and *Polydesmus complanatus,* according to Fitch, causes club foot of cabbage. We find no records of any species having been injurious to radishes. While hunting down the above culprits, other species of millipedes were found in the forcing houses and are included below. Though not detected biting the roots of plants, their presence is objectionable as they feed upon organic matter that might be appropriated by plants. So far as we know, no species of *Myriopoda* have been reported from Maine, and this article may be regarded as a small contribution to the subject.

We are under obligations to Prof. O. F. Cook of the Department of Agriculture, Washington, D. C., for the examination of specimens, and to Mr. L. H. Horner of the Junior Class of the University of Maine for Figs. 2 and 4. Figs 1 and 5 are after Wood and Fig. 3 a camera sketch by the writer.

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*Millipedes are supposed to usually feed upon decaying organic matter. We doubted for a long time that their work upon radishes was primary but from a careful study of the problem are forced to believe it.

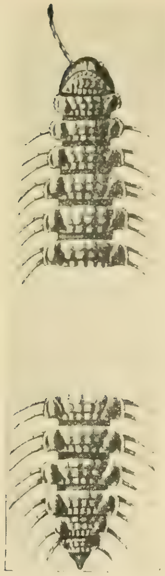


FIG. 5.

FIG. 4.

FIG. 2.

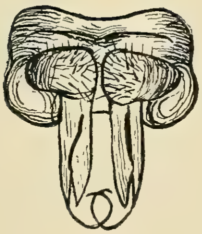


FIG. 1.

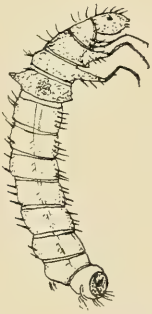


FIG. 6.

FIG. 3.

FIG. 7.

Polydesmus monilaris C. L. Koch—*P. serratus,* Wood.

Description: Deep brown. Antennæ pubescent, club-shaped; the dorsal plates of the segments armed with two rows of scales and a broad anterior obsolete series, their lateral margins toothed. Length one-third to one-half inch. The male genitalia hairy with a double terminal spine. See Fig. 1. Head and terminal segment, Fig. 5.

Remarks: This was originally described from Pennsylvania specimens and is a native species. In Maine it is the most common form found in cellars and under boards and rubbish everywhere out of doors. It is abundant in the greenhouses of Orono in the radish beds, and is one of the culprits, having been caught several times with its mouth in contact with the tubercles found on radishes.

Iulus hortensis, Wood.

Description: Brown, ornamented with a row of black spots on the side; antennæ rather short; hairy, slender, club-shaped; segments of the body 42; scuta closely channeled, both above and below; spine at the end of the body wanting; plate in front of the anus triangular, with its apex rounded. Length, 1 inch. The head and terminal segments are shown enlarged five times in Fig. 2.

Remarks: The young and the adults which have just molted are lighter colored and show the spots on the sides plainly. The spots do not show well on fully colored specimens.

This species is abundant throughout the greenhouses at Orono, and particularly so in the radish beds. It has also been caught biting the radishes, causing excrescences.

Iulus virgatus, Wood.

Description: Deep brown; back yellowish; median dorsal line black; antennæ moderately large, pilose, club-shaped; segments 30-35. Dorsal plates distinctly grooved. Spine at the end of the body wanting, anal scale sparsely hairy; preanal scale, broad, subtriangular with a rounded apex. Length from ½ to ¾ inch.

Remarks: The sides of the body of well colored specimens are deep brown or almost black. The dorsum approaches a fawn yellow and the median dark line is pronounced. Our specimens do not show the lateral bands mentioned by Wood and Bollman

but are otherwise characteristic. We have found but very few specimens of this species about the greenhouse and no damage has been traced to it. It occurs in a cellar in Orono under boxes and barrels. It was probably brought into the cellar in dirt used for storing celery and roots, and into the greenhouses with plants brought in for the winter. It has been reported from Pennsylvania, District of Columbia and Indiana. It is without doubt indigenous to Maine.

Paraiulus immaculatus Wood.

Description: Deep reddish brown without spots; antennæ rather long, slender and hairy; anterior margin of the head notched; segments 48-51; dorsal plate channeled below; the spine at the end of the body, large, hooked, robust, acute. Length, 1 to 1½ inches.

Remarks: Was originally described from specimens collected in the Catskill Mountains, N. Y. It is found in the woods of Maine, and also is quite common in the greenhouses at Orono. As leaf mold and sphagnum from this locality are used in the beds, this species was introduced that way. So far as we know it has done no injury.

Orthomorpha gracilis C. L. Koch.

Description: Dark mahogany brown with the lateral laminæ prominent and yellow, giving the appearance of a yellow stripe along each side. Length, about an inch. The male genitalia are shown much enlarged in Fig. 3, and the head and terminal segments enlarged two and one-half times in Fig. 4.

Remarks: Widely introduced in greenhouses in Europe and America. Found throughout the tropics and according to Prof. O. F. Cook probably a native of the Malay region. At Orono it is found in abundance under pots in the sphagnum moss on the shelves, and also about the roots of plants, near and in the holes in the bottoms of the pots. Some times a half dozen specimens were taken from under a single pot. This species has never been found in the radish beds, but in a section of the house devoted to tropical and other plants in pots. It was probably introduced with some of the tropical plants. Whether it does injury to these plants we are not certain. We are of the opinion that it feeds on the decomposing sphagnum and other organic matter present.

REMEDIES.

No remedies other than hand picking have been tried in the houses at Orono. It has been found that the millipedes work at night mostly, and early in the morning are found near the surface of the ground. During the day, they burrow and are more difficult to find. The morning, therefore, is the best time to hunt for them. They do more injury in sub-watered than in surface watered beds. We would suggest putting slices of potatoes poisoned with strychnine in the beds. Of course, if this or any other poison is used, the radishes should be carefully washed before marketing. Chips of wood scattered in the beds afford hiding places and these could be examined in the morning for specimens. A more troublesome way is to heat the dirt used in the beds. This could be done by connecting a heating box containing a coil of perforated pipes with the engine, or by forcing steam into the dirt in the beds by means of a hose and nozzle.

AN INJURIOUS CADDICE FLY.

F. L. Harvey.

Family Limnephilidæ; Genus Limnephilus; Sp.

In the latter part of June, 1898, we received some caddice fly larvæ, their cases and their work from Mr. William Miller, manager of the Mt. Desert Nurseries, Bar Harbor, Maine. Mr. Miller stated regarding them: "That they have practically eaten up our hardy water lilies. I send you portions of the stem and leaf, illustrations of their work. As soon as we discovered what was destroying them, we took steps to eradicate them, and also removed all of the decayed and badly damaged foliage which remained. Our hardy aquatic pond will contain, perhaps, 300-350 square feet. The first three days one man gathered each day, about 3 gallons of the case worms. In another week or ten days, there would not have been a particle of leaf or stem in the pond. Some of the kinds are completely killed out and two-thirds of the pond is bare that was practically full last year. Since we have been keeping them down by hand picking, those that were strong enough and not destroyed before the trouble was discovered, have made a rapid and wonderful growth. Of course, in a large or deep pond, hand picking would be out of the question. Having control of the water level, we lowered it so as to reach them. The larvæ crawled up the stems of the lilies literally covering them. The stems were badly eaten, often nearly gone, also the under sides and margins of the leaves were attacked. I should like to know what they are? Is there anything that can be done to destroy them besides hand picking? Any information you can give in regard to destroying them would be gladly received, and I should like to know if they have been before reported as giving much trouble."

The injury being new to us, we wrote Dr. L. O. Howard of the Division of Entomology, United States Department of Agri-

culture, Washington, D. C., who informed us that the injury was also new to him. As caddice flies cannot be classified beyond the genus by the cases and larvæ, we wrote to Mr. Miller to catch some of the flies for us. Such thorough hand picking had been done that probably no larvæ were left to emerge, and though the pond was watched during the season, no flies were taken. The larvæ sent us by Mr. Miller were dead when received so we were not able to rear the flies.

During August we were in Bar Harbor and visited the Mt. Desert Nurseries and examined the pond. No caddice flies were then on the wing. We arranged with Mr. Miller to transfer some of the case-worms to a tub in the house and try to rear the flies. Later he informed us that no live case-worms could be found. Should they give trouble again, we will investigate farther.

We sent some of the cases to Mr. Nathan Banks who thinks they belong as placed below. To Mr. Miller, we made the following reply:

"The case-worms you sent belong to the Order *Trichoptera* (Caddice Flies), Family *Limnephilidæ,* Genus *Limnephilus.* It will be necessary to have the flies to decide the species. I send you a drawing of a species of caddice fly and wish you would send me any related insects you find about the pond.

"Caddice flies lay their eggs upon the surface of water plants. The young make cases in which they live, or some species appropriate the hollow stems of water plants. Some of them are carnivorous and feed upon other insects, but most of them are vegetable feeders. But little is known about their food habits excepting that many feed on water plants. The injury was entirely new to me. There is no record of caddice flies having been injurious to water lilies. They might commonly feed upon our wild species and the habit be overlooked as the plants are not of economic importance. They might have been in your artificial pond in some number and have been overlooked. It was the unusual number that attracted attention. As you have control of the water level in the pond, there is no better remedy than hand picking, or cleaning the pond in the winter. As you have done a thorough job of hand picking, probably you will

never be troubled with them in such numbers again. We will be pleased to investigate farther should they continue to trouble you."

DESCRIPTION OF CASES AND LARVÆ.

Cases about three-fourths of an inch long and one-fourth wide. Of the log-house pattern. They seem to be built of fragments of water-lily stems. One of them ornamented with the case of a smaller species. Fig. 7 shows six of these cases, natural size.

Larvæ about three-fourths of an inch long. The portion within the case pale brown; the protruding thoracic segments and head much darker. The portion within the case provided with blunt hairs. The first abdominal segment enlarged and produced into tubercles above at the sides and below, to attach the larvæ to the case. Fig. 6 shows the larva enlarged two times.

INSECTS OF THE YEAR.

F. L. Harvey.

Short-nosed Ox-louse. (*Hœmatopinus eurysternus.*)

This species is found about Orono and is probably common in Maine, though it has never been sent to the Station before this season. The *Long-nosed Ox-louse* was reported in 1895. For description of these parasites see Experiment Station Report, 1895, page 99.

Walking Stick. (*Diapheromera femorata.*)

Specimens of this curious wingless insect were received from J. H. Hammond, Sanford. This species is certainly rare in Maine. These are the first we have seen from the State.

Apple-tree Aphis. (*Aphis mali* Fabr.)

Was reported as doing much damage to the foliage of apple trees and plum trees in several localities. Spraying with kerosene is probably the best remedy. The application should be made as soon as the insects appear. This insect is considered in Experiment Station Report 1888, p. 170.

Caddice Fly.

The larva of a caddice fly was reported as doing damage to water lilies in an artificial pond at Bar Harbor. Considered in detail elsewhere.

Bud Moths.

Several species of bud moths were reported the past season as doing much damage to the terminal buds and flower buds of apple trees. Spraying with Paris green as soon as the leaves begin to unfold, ought to destroy them.

THE RED HUMPED APPLE WORM. (*Œdemasia concinna.*)

Was reported from several new localities the past season. It seems to be on the increase in Maine. See Experiment Station Report, 1890, p. 135.

FALL CANKER WORM.

This insect continues to do some damage in Southern Maine. It will be remembered that it went across the State in a wave from the northeast to the southwest. It was also reported the past season from Aroostook county.

THE ZEBRA CATERPILLAR. (*Mamestra picta.*)

This is one of the most common caterpillars in gardens and cultivated fields. It is a general feeder found on a great variety of plants. See Experiment Station Report, 1897, pages 173 and 175.

APPLE-TREE TENT CATERPILLAR. (*Clisiocampa americana.*)

Was, as we predicted, very abundant particularly in southern and western Maine. The farmers who took care of their trees last year are now reaping the benefit, as the apple crop was short and apples are high.

THE BROWN TAILED MOTH.

Mr. Andrew Whitehouse, South Berwick, Me., upon whose premises the above pest was found in 1897, writes February 2d as follows: "I cannot find any specimens to send you. In the summer of 1897, my boy was badly poisoned by them. They were numerous on a woodbine on my premises and a few on my fruit trees. Last year I cut down the woodbine and burned it, and have not seen any since." Mr. Whitehouse thinks they came from Somerville, Mass., on roses.

The usual number of luna, cecropia and polyphemus moths were received. We received a polyphemus cocoon that was spun in a stocking. The caterpillar climbed up a post and out on the line to where the stocking hung, then down and into the stocking. When found the stocking had been on the line only a few hours.

Drone or Chrysanthemum Fly.

The larvæ of these flies have long breathing tubes at the end of the body which give them the name of rat-tail larvæ. Specimens reported were breeding in a tub containing a decoction of tobacco stems. We found the larvæ abundant at McLeod's lumber camp in a tub by the blacksmith's forge containing stagnant water.

Apple Maggot. (*Trypeta pomonella.*)

Was not as prevalent as usual, though doing considerable damage in some parts of the State.

Currant Fly. (*Epochra canadensis.*)

Was reported from Gardiner on currants. It was common also about Orono. We would like to hear from anybody whose currants are stung by a fly and turn red early, and drop.

Fickle Midge. (*Sciara inconstans.*)

This was reported last season as attacking gloxinia bulbs. The same complaints have been made the past season. Mrs. R. S. Warren, South Deer Isle, sent us specimens which she called springtails that were eating the leaves and blossoms. She writes, "I am positive now that the springtails destroy my gloxinias, for I have found them on the blossoms and stems where they had eaten the stem half through and the blossoms withered. Also they burrow into the leaves and sap them until they dry up and die." The specimens sent were Thysanurans and an unknown species of Thrips. The latter were no doubt the cause of the injuries. Mrs. Warren put slices of potato around the plants and the insects collected on them in great numbers. Probably the use of the potato as traps would be a good way to destroy them.

Buffalo Carpet Beetle. (*Anthrenus Scrophulariæ.*)

Reported from Winthrop and Orono. Beetles in the house. These beetles are attracted by flowers that are in bloom at the time when they are on the wing, and they can be used as traps. The following from the Thirteenth Report of the Entomologist of the State of New York, page 359.

"Mr. M. B. Coombs of Utica, N. Y., writes, 'My sister has for several years kept a bed of small tulips for drawing the beetles. They congregate almost entirely on the creamy or yellow shades. For about two weeks with a pair of tweezers she picked out from them from two to three dozen on unfavorable days, and hundreds on quiet sunny days.' "

MAY BEETLE. (*Lachnosterna fusca.*)

Mr. Kirk of Bar Harbor sent grubs of the above species and wrote as follows: "They have worked under the surface of the turf about two inches and eat everything before them. They have killed outright about 15,000 square feet of my tennis court. Most of the damage was done in July and August. I have had the infested ground dug up and the insects picked out. I have picked up more than a bushel." We wrote Mr. Kirk, calling his attention to the remedies usually applied for white grubs.

CUCUMBER BEETLE. (*Diabrotica vittata.*)

This beetle that usually confines itself to cucurbitaceous plants was reported the past season as feeding on the buds of cultivated asters.

POTATO STALK BORER. (*Gortynia nitela.*)

Continues to do some damage to potato plants.

BLACKBERRY CANE BORER. (*Oberea bimaculata.*)

Reported from western Maine. Also abundant at Orono on blackberries and raspberries.

STRAWBERRY WEEVIL. (*Anthronomus signatus.*)

Does some damage to strawberries. More common on wild than on cultivated plants.

PEAR TREE SLUG. (*Eriocampa cerasi.*)

Reported as injuring the foliage of cherry trees.

INSECTS EXAMINED IN 1898.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Short-nosed Ox Louse	*Hæmatopinus eurysternus*	Chas. N. Wells, Auburn	On cattle. See Ex. Sta. Rept. 1895, p. 99.
2	Walking Stick	*Diapheromera femorata*	J. H. Hammond, Sanford.	
3	Apple-tree Aphis		T. D. Salley, Madison J. S. Blackwell, Madison O. B. Griffin, Reynolds F. E. Gilman, Foxcroft Austin Stover, Bluehill	On apple and plum trees.
4	Oyster-shell Bark-louse	*Mytilapsis pomorum*	Z. A. Gilbert, from Camden	On apple trees.
5	Caddice Fly	*Species unknown*	Wm. Miller, Bar Harbor	Destroying water lilies in an artificial lily pond.
6	Bud Moths	*Several species*	L. L. Phillips, Hebron	On apple trees.
7	Red-humped Apple-worm	*Œdemasia concinna*	Austin Stover, Bluehill O. B. Griffin, Reynolds Mrs. A. M. Hustin, Winn	On apple trees.
8	Fall Canker-worm	*Alsophila pometaria*	V. T. Lundvall, New Sweden. Mowe F. Article, Camden	On apple trees.
9	Zebra Caterpillar	*Mamestra picta*	Austin Stover, Bluehill A. J. Abbott, North Paris O. F. Guptil, West Scarboro I. N. Lapham, Pittston	On strawberries, pea vines, carrots and raspberries.
10	White-marked Tussock-Moth.	*Notolophus leucostigma*	C. Henry Page, Winthrop Chas. N. Wells, Auburn	On apple trees.
11	Salt-Marsh Caterpillar.	*Estigmene acræa*	B. Walker McKeen.	
12	Fall Web-worm	*Hyphantria cunea*	B. Walker McKeen, Hancock Co.	On apple trees.
13	Gooseberry Span-worm	*Diastictis ribearia*	F. L. Harvey, Orono.	On gooseberries.
4	Luna Moth	*Tropæa luna*	Samuel L. Boardman, Bangor	A night flying species.

INSECTS EXAMINED IN 1898—CONCLUDED.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
15	Cecropia Emperor Moth	*Samia cecropia*	A. O. Butler, East Lebanon	Apple trees.
16	Polyphemus Moth	*Telea polyphemus*	V. T. Lundvall, New Sweden.	
17	Apple-tree Tent-Caterpillar	*Clisiocampa Americana*	Various parties southwestern Me.	On apple trees.
18	Tiger Swallow-tail Butterfly	*Jasoniades glaucus turnus*	Chas. A. Moulton, Buxton.	
19	Clouded Sulphur Butterfly	*Eurymus philodice*	R. T. Young, North Hancock	Feeding on clover.
20	Drone or Chrysanthemum Fly		M. Henry McLaughlin, Bangor	Larvæ in decoction of tobacco stems.
21	Currant Fly	*Epochra canadensis*	H. K. Morrell, Gardiner	Infesting currants.
22	Fickle Midge	*Sciara inconstans Fitch*	Mrs. R. S. Warren, So. Deer Isle	On gloxinia plants.
23	Sheeptick	*Melophagus ovinus*	Job Abbott, Dexter	Parasite on lambs.
24	Carpet Beetle. Buffalo Beetle	*Anthrenus scrophulariæ*	C. Henry Page, Winthrop	Attacking carpet. Beetles on window in house.
25	May-beetle. June-Bug.	*Lachnosterna fusca*	E. Kirk, Bar Harbor.	Destroyed 1,500 square feet of tennis court in July and August.
26	Cucumber Beetle	*Diabrotica vittata*	Mrs. Lucy Hutchins, Fryeburg Mrs. Alice Buzzell, Fryeburg	Attacking aster heads.
27	Ribbed Pine Borer	*Rhagium lineatum*	Chas. A. Moulton, Buxton.	
28	Potato-Stalk Borer	*Gortyna nitela*	A. O. Butler, East Lebanon O. B. Griffin, Reynolds	Boring in potato stalks.
29	Blackberry Cane Borer	*Obesea bimaculata*	A. W. Grover, Bethel	Attacking blackberry and raspberry canes.
30	Goldsmith Beetle	*Catalpa lanigera*	W. R. Atherton, Hallowell.	
31	Strawberry Weevil	*Anthonomus signatus*	F. A. Fisher, Bluehill	On strawberries.
32	Pear-tree Slug	*Eriocampa cerasi*	Austin Stover, Bluehill	Feeding on cherry.

NOTES ON THE PLANTS OF THE YEAR.

F. L. HARVEY.

Specimens of the plants mentioned below were examined during the year. The weeds received agree well with weed seeds found in seed offered for sale in Maine. Judging from increased correspondence, farmers are awakening to the importance of better seed and the necessity of carefully watching their fields to prevent the introduction and spread of new weeds. A large number of samples of seeds sold in Maine were examined the past season and over sixty kinds of foreign seeds detected.

But few fungi were reported as doing damage the past season.

HOLLYHOCK RUST. (*Puccinia malvacearum.*) This disease has established itself in Maine.

POTATO BLIGHT. (*Phytophthora infestans*). Was quite bad in some portions of Maine, but not so prevalent as in 1897.

WILD PEPPER GRASS. (*Lepidium virginicum and apetalum.*) In newly seeded land. The clover seed sold in Maine contains the seeds of these weeds.

WILD TURNIP. (*Brassica campestris.*) Appeared in fields sowed with western clover seed.

WILD MUSTARD. (*Sinapis alba.*) In land seeded with western clover seed. This is not as common in Maine as several other cruciferous weeds.

PURPLE MILKWORT. (*Polygala viridescens* L.) Growing along roadsides and in meadows. Not a bad weed.

ROUGH CINQUEFOIL. (*Potentilla monspeliensis.*) In newly seeded land. The seeds of this plant are abundant in Timothy seed sold in Maine.

BIENNIAL WORMWOOD. (*Artemesia biennis.*) Dooryards and waste places. Not a bad weed.

MAY WEED. (*Anthemis cotula.*) Waste places and fields. A bad weed. Found in Timothy seed.

Orange Hawkweed. (*Hieracium aurantiacum.*) Reported from several new localities.

King-Devil Weed. (*Hieracium prœaltum.*) Reported from Albion, Vassalboro, Exeter Mills, Carmel and Litchfield. Mr. H. K. Morrell writes as follows: "We found three patches of this pest in the bog woods of Litchfield and pulled it all up. The field formerly owned by Bartlett and Dennis in West Gardiner, where it is said to have first made its appearance, is as yellow as gold over the most of it. In a few days the seed will be ripe enough to fly by the wind. The State should take charge of such fields." In the vicinity of Riverside, on the east side of the Kennebec, this pest occurs on several farms. Exeter Mills where it has been found this season by Mr. Josiah Eastman is in Penobscot county, a long distance from other locations. Mr. Roy H. Harvey collected specimens in July on the farm of Mr. McLaughlin, two miles east of Carmel village. The locality is fifteen miles west of Bangor. Mr. Morrell's observations show the plant will grow in Maine outside of the fields.

Yellow Goat's Beard. (*Tragopogon pratensis.*) Not a common weed in Maine, but Mr. H. E. Cook of Vassalboro says: "There were thousands in an old field that I have recently come into possession of."

Yellow Daisy. Cone Flower. (*Rudbeckia hirta.*) This weed is abundant in Maine and is increasing. We found the seed of it in Timothy seed samples examined this season.

Clover Dodder. (*Cuscuta epithymum.*) Seems to be on the increase. The bunches of the parasite should be cut, dried and burned. It seems to grow most in second crop clover.

Ground Cherry. (*Physalis Virginiana.*) Reported, but not a common weed in Maine. Apparently not found in the eastern part of the State.

Water Horehound. (*Lycopus Americanus.*) A common weed in low fields and grass lands.

Hemp Nettle. (*Galeopsis Tetrahit.*) A bad weed in gardens, and rich soil in fields. Abundant in Maine.

English Plantain. (*Plantago lanceolata.*) The seeds of this, also dooryard plantain and aristate plantain were found abundantly in seed examined this season.

ROUGH PIGWEED. (*Amaranthus retroflexus.*) A bad weed in gardens and cultivated fields. Germinates late and will perfect its seeds after crops are laid by.

LAMB'S QUARTERS. PIGWEED. (*Chenopodium album.*) A common weed along road sides, waste places, gardens and cultivated fields. Seed abundant in western seed.

POKE-WEED, PIGEON BERRY. (*Phytolacca decandra.*) Not abundant. Reported for the first time, this season. Growing in a potato patch.

FRINGED BLACK BINDWEED. (*Polygonum clinode.*) This is a native bindweed that has been reported as a weed in newly cleared lands.

BLACK BINDWEED. (*Polygonun convolvulus.*) Common in fields and gardens. Western seed contains it in abundance.

VIRGINIA THREE-SEEDED MERCURY. (*Acalypha Virginica.*) Is becoming a common weed in low damp lands. It is an annual, and clean culture should eradicate it. It is native in low woods.

PLANTS EXAMINED IN 1898.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	WILD PEPPERGRASS	*Lepidium Virginicum*	E. S. Stuart, Garland	In newly seeded land.
2	APETALOUS PEPPERGRASS	*Lepidium apetalum*	L. E. Winslow, Mars Hill	Waste places and fields.
3	SHEPHERD'S PURSE	*Capsella bursa-pastoris*	H. B. Whipple, Bingham	In newly seeded land.
4	WILD NAVEW. TURNIP	*Brassica campestris*	L. E. Winslow, Mars Hill H. B. Whipple, Bingham	In newly seeded land.
5	WHITE MUSTARD	*Sinapis alba*	H. B. Whipple, Bingham	In newly seeded land.
6	VETCH	*Vicia cracca*	W. R. Atherton, Hallowell	Grass land.
7	HOP CLOVER	*Trifolium agrarium*	G. W. Chamberlain, W. Lebanon.	Roadsides and fields.
8	PURPLE MILKWORT	*Polygala viridescens L.*	E. G. Lovejoy, Medford Center	Roadsides and grass lands.
9	ROUGH CINQUEFOIL	*Potentilla monspeliensis*	O. B. Griffin, Reynolds	Fields, waste places, roadsides.
10	BIENNIAL WORMWOOD	*Artemesia biennis*	B. L. Fernald, Winn	Waste places.
11	MAYWEED	*Anthemis cotula*	R. E. Winslow, Mars Hill	Yards, roadsides.
12	ORANGE HAWKWEED	*Hieracium aurantiacum*	H. E. Cook, Vassalboro J. T. Brown, Webber	Fields, roadsides, pastures.
13	KING-DEVIL WEED	*Hieracium prœaltum*	Josiah Eastman, Exeter Mills C. E. Crosby, Albion H. K. Morrill, Litchfield Sev'l parties Vass'b'o & Riv'sd R. H. Harvey, Carmel	Cultivated fields and swamp in woods.
14	YELLOW GOAT'S BEARD	*Tragopogon pratensis*	H. E. Cook, Vassalboro	Not a common weed in Maine.
15	YELLOW DAISY. CONEFLOWER	*Rudbeckia hirta*	Various parties Houlton, Riverside, etc	Common through Maine in grass lands.
16	CLOVER DODDER	*Cuscuta epithymum*	E. C. Putnam, Dixmont Center	Parasitic on clover.
17	GROUND CHERRY	*Physalis Virginicaa*	G. M. Twitchell from Thorndike.	Fields.

18	Water Horehound	*Lycopus Americanus*	H. B. Whipple, Bingham B. L. Fernald, Winn	Low grass lands.
19	Hemp Nettle	*Galeopsis Tetrahit*	H. B. Whipple, Bingham	Waste places and gardens.
20	English Plantain	*Plantago lanceolata*	H. M. Gage, Plymouth	Cultivated fields.
21	Rough Pigweed	*Amaranthus retroflexus*	B. L. Fernald, Winn H. B. Whipple, Bingham	Fields and gardens.
22	Lamb's Quarters. Pigweed	*Chenopodium album*	H. B. Whipple, Bingham	Fields, gardens, waste places.
23	Poke-weed. Pigeon-berry	*Phytolacca decandra*	A. O. Butler, East Lebanon	Cultivated field.
24	Mild Water-pepper	*Polygonum hydropiperoides*	H. B. Whipple, Bingham	Low grass lands.
25	Fringed Black Bindweed	*Polygonum cilinode*	H. B. Whipple, Bingham	Newly cleared lands.
26	Black Bindweed	*Polygonum convolvulus*	H. B. Whipple, Bingham	Cultivated ground.
27	Virginia Three-seeded Mercury	*Acalypha Virginica*	R. H. Libbey, Newport Maine Farmer	Low grass land. Cultivated fields.
28	Wood Reed-grass	*Cinna arundinacea*	O. B. Griffin, Reynolds	Fields and woods.
29	Rattle-snake Grass	*Glyceria Canadensis*	O. B. Griffin, Reynolds	Low grass land.
30	Squirrel-tail Grass	*Hordeum jubatum*	Mrs. R. C. Leonard, Passadumk'g	Weed in fields.

TUBERCULOSIS AND THE STATION HERD.

F. L. Russell.

Since some years before 1886 until within two years, some of the cattle kept on the College farm have been affected with tuberculosis, whenever the College has kept any cattle. Before 1886, cattle occasionally died from this disease or in absence of exact knowledge of their condition were sold for beef or otherwise disposed of on account of age or unthriftiness.

Well bred young animals were sold to improve other herds and sometimes carried tuberculosis with them. This is a very common way of spreading tuberculosis, but with our present knowledge, it ought to be very generally avoided.

In 1886, the College cattle were so badly diseased that it was considered best to kill the entire herd, as at that time there was no known means by which the diseased animals could be detected with any certainty. After the herd was destroyed the barns were disinfected with some care and no new stock was introduced for about a year.

In 1889, considerable new stock was purchased from different sources and in less than a year from the time they were purchased, two of them were found to be diseased and were killed. Again the barn was disinfected, but new cases of disease were frequently being discovered in the herd. In 1892, tuberculin became available for the detection of tuberculosis, and some time before it was used in other parts of the State, we were conducting experiments to test its value.

In 1893, we had become convinced of the value of tuberculin as a revealer of the presence of tuberculosis and took what was then rather radical ground, and after testing every bovine on the farm, down to the youngest calf, those that reacted to the test were killed. This made a large hole in the herd and required the sacrifice of some of the most valued animals, but we believe the results have fully justified the course taken.

In order to meet the demands for dairy products it was considered necessary to replace the cows killed, and ordinary grade and native cows that answered the requirements were purchased from nearby sources. Every precaution was taken to procure sound animals, and before they were introduced into the barns, they successfully passed the tuberculin test, *but as it was late in the fall and the barn was full of hay and grain, it was not considered practicable to disinfect the barn.* The lintel was disinfected but not the rest of the barn until the following summer.

During the winter of 1893 and 1894 and the following spring, several cases of tuberculosis developed, some of them being cows purchased the fall before, from healthy herds, and according to every known test, healthy animals themselves. They must have contracted the disease in the College barns. In the summer of 1894, the barn was disinfected and since that time comparatively few cases of tuberculosis have been found, the last case being discovered in the fall of 1897. In 1896, the barn was again disinfected in a very thorough manner. Since then we have found but two cases and each of them was discovered before it was possible that they should have infected their surroundings or other cattle. Since October 1897, no new case has been discovered, although the entire herd was tested in 1897 and again in 1898. We now feel justified in making the claim that since October 1897, the herd has been entirely free from tuberculosis for perhaps the first time in its history, although we are aware that it is possible that among the older animals there may be one or two that have been infected for years and may develop the disease at any time. The herd now numbers fifty-one head of all ages, most of these bred on the farm.

Some mistakes have been made without doubt, and it was unfortunate that means were not earlier discovered for accomplishing the end we have now reached, but if there has been anything exceptional in our experience with tuberculosis, it consists in the fact that in about three years' time we have exterminated the seeds of the disease from a badly infected herd and premises without sacrificing either to any great extent. Other colleges and experiment stations situated as we were in 1894 have felt it necessary to destroy buildings and cattle and in one instance, at least, import range cattle that it was assumed had

never been exposed to tuberculosis. In getting rid of tuberculosis, we have used no means but what are at the command of any stock owner. In the first place, we have not harbored diseased cattle to serve as sources of contagion. As soon as their condition has been discovered, they have been destroyed. Since we have relied on the action of tuberculin, many animals that were doing good work and were apparently well have been sacrificed, but the autopsy has almost invariably justified the course taken, and in pursuing this course, we have doubtless saved more animals than we have destroyed. We have saved animals that would have become diseased if infected animals had been allowed to associate with them and infect their surroundings. The animals destroyed had been valuable, but the most skeptical in regard to the danger of bovine tuberculosis would hesitate before paying much for them with a full knowledge of their diseased condition. No animals have ever been sold from the College herd for any purpose that were even suspected of being diseased.

Tuberculin is not infallible by any means. Animals infected with tuberculosis in which the disease is dormant, making no progress for the time being, usually fail to react under the tuberculin test, and again, many animals that do react are so slightly diseased that it is possible or even probable that they might be safely kept for some time, but we know of no way by which these slightly diseased cattle can be distinguished from those in which the disease is more advanced, so that they would not be safe animals to keep. Again, the slightly diseased animal may, nobody can tell how soon, become a dangerous animal to have in a herd. Our observation has been that when cattle have tuberculosis in a sufficiently advanced stage so that it can be detected by any other than the tuberculin test, their days are usually numbered, they have already done their work of spreading contagion, and it matters little whether they are allowed to die from disease or are killed on the verge of the grave.

In addition to getting rid of diseased cattle to avoid infection, we have endeavored to get rid of the disease products that the cattle have left in the barns. The only active cause in the spread of tuberculosis is the tubercle bacillus. This germ is given off through various channels from tuberculous cattle and

it is found in the barns the cattle have occupied, and it may lie there for months after the cattle have been removed. That this is no imaginary condition has been demonstrated many times by finding this germ in the dust of buildings where tuberculous animals have been kept and testing its life on small animals to which it has conveyed the disease.

We consider it quite as important to kill these disease germs as to kill the cattle that produce them. To kill the tubercle bacilli left in the barn by the diseased cattle has been our object in disinfecting the barns, and of course it has been necessary to disinfect as often as the barns have become infected by diseased cattle and no oftener. We shall not have occasion to disinfect them again unless we have another case of tuberculosis that makes sufficient progress before we discover it so that the germs of the disease are given off and reinfect the barns. The principle involved in the disinfection is to bring in contact with the disease germs some substance that will kill them. We have used for this purpose corrosive sublimate. In detail, the method employed is as follows:

All the hay, grain and farming tools have been removed from the barns, the only exception being the hoes, shovels and forks that have to be used there. Every movable thing that has been in the barn with the diseased cattle, or after the diseased cattle were removed, before the barn was disinfected, was taken out, or, if left in the barn, was disinfected the same as the barn itself. Then with brooms all dust and dirt that could be moved, was swept into the basement or out of doors into the sunlight. Then with a hand pump mounted on a barrel, such a pump as is commonly used for spraying orchards or potato fields, the disinfecting solution was thrown with considerable force against *every inch* of the wood work of the barn, into every *crack* and *crevice* where dust, laden with disease germs, might lodge. We commenced in the roof and worked downward, making thorough work of it as we went along. By using the pump we did not find this a very expensive operation. Including the cost of the material and the labor, the expense of cleaning and disinfecting a barn 100x50 feet with 18 feet posts and basement, was about $25.00. This did not include the cost of the pump which was but little injured, and has before and since that time been used

for other purposes. The disinfecting solution was made by dissolving one part, by weight, of corrosive sublimate in about a thousand parts of water. The pump was mounted on a fifty gallon barrel and we used a little more than a half pound of the sublimate for a barrel of water. We bought the pulverized corrosive sublimate and dissolved it in hot water. It dissolves very slowly in cold water. The sublimate and its solution should be kept in glass or wooden vessels; it corrodes metal. The solution is poisonous if taken in sufficient quantities, so it should never be left uncovered where animals can get at it.

Another means that we have used in keeping our herd free from tuberculosis has been the testing with tuberculin of all animals purchased. By this means we have avoided purchasing diseased animals that were satisfactory in other respects, and if we were to neglect this precaution, we might easily undo all that we have accomplished. When we could do so conveniently, the animals purchased have been tested before they were brought to the farm. In other cases they have been tested here before they were admitted to the barns with the other cattle. In two cases, we have avoided introducing tuberculous cattle into the herd by this very simple precaution.

SUMMARY.

The College herd of cattle has never, prior to 1897, for long at a time, been entirely free from tuberculosis for nearly twenty years.

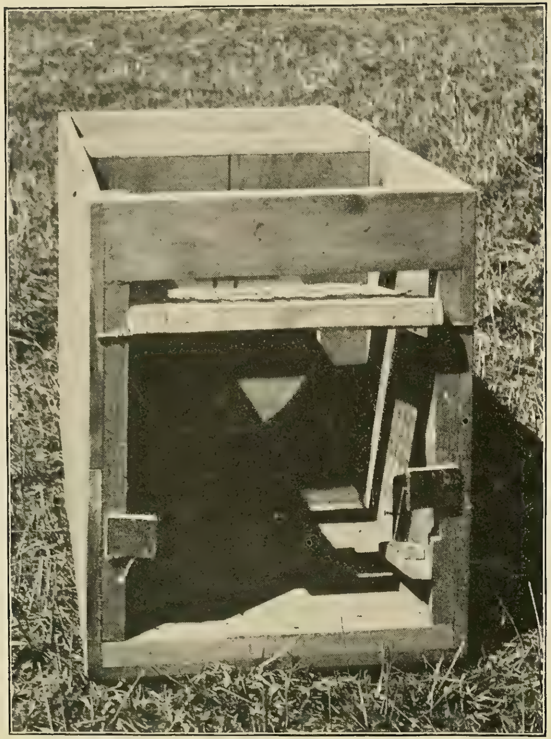
The entire herd was killed once to get rid of the disease.

It was again introduced with cattle purchased; since 1894 we have been making rapid progress in getting rid of the disease.

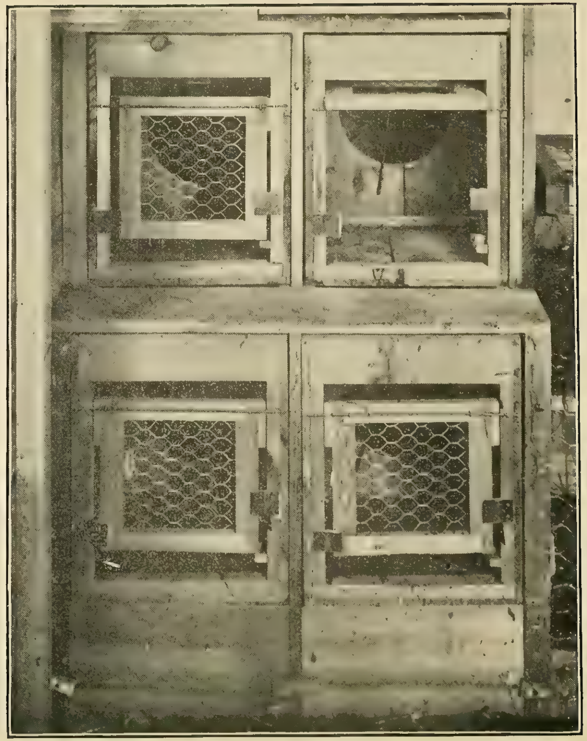
We have not been able to discover any cases for more than a year and a half and believe the herd, numbering fifty-one head, most of them bred on the farm, is now free from tuberculosis.

The herd has been freed from tuberculosis by first, killing all the animals that reacted to tuberculin; second, thoroughly disinfecting the barns where tuberculous cattle had been kept; third, carefully inspecting all cattle purchased into the herd.

The methods used for getting rid of tuberculosis are easily available and not expensive.



Single nest removed.



Nests in position.

INDIVIDUAL RECORD NESTS.

A NEST BOX FOR KEEPING INDIVIDUAL EGG RECORDS.

G. M. Gowell.

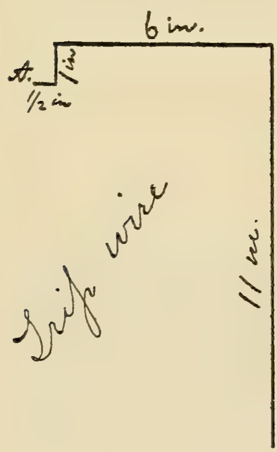
Desiring to conduct experiments in breeding hens, we found it necessary, first, to be able to determine the eggs produced by each individual. Several appliances and patented devices were examined, but all seemed open to the objection, that while they might indicate to an extent the producer of the egg, the lack of certainty would be so great as to render them of little value for our purpose. We constructed a nest that proved so satisfactory, that we placed fifty-two of them in the breedinghouse, where they have been in use several months. They enable us to know the eggs produced by each bird with certainty. The boxes are placed four in a bank, and slide in and out like drawers and can be carried away for cleaning if necessary. If desired, they could be put on the floor or shelf by simply having a cover to each box.

Our breeding pens are ten by sixteen feet in size, and there are twenty hens and a cockerel in each one. Four nests in each pen have accommodated the birds by the attendant going through the pens once an hour during that part of the day when the birds were busiest. Earlier and later in the day, his visits have not been so frequent. More nests in the pen would reduce the frequency of his visits. To remove a hen, the nest is pulled part way out and as it has no cover, she is readily lifted up and the number on her leg band noted on the record sheet that hangs at hand. After having been taken off a few times, they do not object to being handled, the most of them remaining quiet, apparently expecting to be picked up.

The nest box is very simple, inexpensive, easy to attend and certain in its action. It is a box-like structure, without front end or cover. It is 28 inches long, 13 inches wide and 13 inches deep—inside measurements. A division board with a circular

opening 7½ inches in diameter is placed across the box 12 inches from the back end and 15 inches from the front end. The back section is the nest proper. Instead of a close door at the entrance, a light frame of inch by inch and a half stuff is covered with wire netting of one inch mesh. The door is ten and one-half inches wide and ten inches high and does not fill the entire entrance, a space of two and a half inches being left at the bottom and one and a half inches at the top, with a good margin at each side to avoid friction. If it filled the entire space it would be clumsy in its action. It is hinged at the top and opens up into the box. The hinges are placed on the front of the door rather than at the center or back, the better to secure complete closing action.

The trip consists of one piece of stiff wire about three-sixteenths of an inch in diameter and eighteen and one-half inches long, bent as shown in the drawing. A piece of board six inches wide and just long enough to reach across the box inside is nailed flatwise in front of the partition and one inch below the top of the box, a space of one-fourth of an inch being left between the edge of the board and the partition. The purpose of this board is only to support the trip wire in place. The six-inch section of the trip wire is placed across the board and the long part of the wire slipped through the quarter inch slot, and passed down close to and in front of the center of the seven and a half inch circular opening. Small wire staples are driven nearly down over the six-inch section of the trip wire into the board so as to hold it in place and yet let it roll sidewise easily.



When the door is set, the half inch section of the wire marked A comes under a hard wood peg or a tack with a large round head, which is driven into the lower edge of the door frame. The hen passes in through the circular opening and in doing so presses the wire to one side, and the trip slips from its connection with the door. The door promptly swings down and fastens

itself in place by its lower edge striking the light end of a wooden latch or lever pressing it down and slipping over it, the lever immediately coming back into place and locking the door. The latch is five inches long, one inch wide and a half inch thick, and is fastened loosely one inch from its center to the side of the box, so that the outer end is just inside of the door when it is closed. The latch acts quickly enough to catch the door before it rebounds. It was feared that the noise arising from the closing of the door might startle the hens, so instead of wooden stops, pieces of old rubber belting were nailed at the outside entrances for the door to strike against.

The double box with nest in the rear end is necessary, as when a bird has laid and desires to leave the nest, she steps to the front and remains there until released. With one section only, she would be very likely to crush her egg by standing upon it.

One experiment which has been undertaken and which requires a long period of time in preparation is the attempt to establish families of hens that shall excel as egg producers. To do this, reliance upon the laws of inheritance and transmission must be coupled with selection. Selection will depend upon the actual production of the birds taken for foundation stock. From offspring of the foundation stock will be selected—by use of the nest boxes—the greatest yielders of desirable eggs.

The male birds will be bred from dams of known capacity and quality. Only by use of nest boxes and leg bands can we expect to control the work. Two hundred and sixty females, from three distinct breeds, are undergoing test for the foundation stock. One year's time will be required in the selection. From among them it is hoped may be found a few birds that are suited for the founding of the families. The breeds employed are Barred Plymouth Rock, White Wyandotte and Light Weight Light Brahma.

THE NUMBER OF LAYING HENS THAT CAN BE PROFITABLY KEPT IN ONE PEN.

G. M. Gowell.

To obtain data relative to the number of hens that can be kept in a room of a given size, and the receipts from the same, a test was made with fifteen pens of birds, of two breeds.

In the Station poultry building were fifteen pens, alike in size and arrangement. Each pen was ten by sixteen feet on the floor. It was five feet high at the back and eleven high at the front. Each pen had the same amount of window surface in the south side. The roosts, gravel, bone and water dishes and nests were arranged the same in all of the pens. The entire floor space of one hundred and sixty feet was available to the birds, as the walk was elevated above the floor so as not to interfere with its use. Equal yard space was attached to each room.

The birds employed were all of the same age—hatched May 2d—except those in pen No. 1 which were hatched April 16th. Care was exercised in selecting, to have all of the birds in the pens of a group as nearly alike in size, form and vigor as possible.

GROUP 1.

Pen No. 1 had fifteen Brahma pullets.
Pen No. 2 had twenty Brahma pullets.
Pen No. 3 had twenty-five Brahma pullets.
Pen No. 4 had thirty Brahma pullets.

GROUP 2.

Pens Nos. 5, 6, 7, 8, were duplicates of Nos. 1, 2, 3, and 4.

GROUP 3.

Pen No. 9 had fifteen Barred Plymouth Rock pullets.
Pen No. 10 had twenty Barred Plymouth pullets.
Pen No. 11 had twenty-five Barred Plymouth pullets.
Pen No. 12 had thirty Barred Plymouth Rock pullets.

GROUP 4.

Pens Nos. 13, 14 and 15 were duplicates of Pens Nos. 9, 10, 11.

The birds in all the pens received the same quality of food. All food was distributed among the pens of a single group in proportion to the number of birds each one contained. The birds in group No. 2 were not so well developed as those in other groups and were fed according to their needs. All birds in a single group were fed the same quantity. Uniform care and treatment prevailed. Two birds were lost by accident during the winter. A good supply of dry straw was kept on the floors at all times, and the birds were induced to exercise freely. The only lack of uniformity in conducting the test was in group 1, pen 1, where older birds were used than in other pens, which results in a more favorable showing than can be ascribed to numbers alone.

It was intended to carry the test through the year, but the building was destroyed by fire early in May, thus terminating the test at six months. For the purpose of this test only, it may be that the period from November first to May first represents better the influence of the floor space than would be the case when summer runs were added.

In examining the data, it should be remembered that each group forms a test independent of other groups. This is important as the birds in different groups are not alike, but all the birds in pens comprising a single group are uniform.

The uniformity of the results in every group are such as lead to the conclusion that as we increase the numbers of birds above fifteen on a floor space of one hundred and sixty feet, the egg yield diminishes as the number of birds increase. This testimony is emphatic, as among the four groups there was not a single exception to this conclusion.

The three tables which follow give the egg records for six winter months.

YIELD OF EGGS DURING SIX WINTER MONTHS OF HENS KEPT IN FLOCKS OF 15, 20, 25, AND 30 COMPARED.

Number of group.	Number of pen.	Number of birds.	Eggs Yielded.							
			November.	December.	January.	February.	March.	April.	Total.	Per bird.
1	1	15	186	261	237	122	194	260	1,260	84
	2	20	148	245	269	124	220	268	1,274	63.7
	3	25	104	277	232	125	251	381	1,370	54.8
	4	30	81	171	235	147	255	345	1,234	41.1
2	5	15	24	151	213	102	180	236	906	60.4
	6	20	66	207	224	127	204	326	1,154	57.7
	7	25	55	148	233	114	204	298	1,052	42.1
	8	30	34	138	212	111	266	390	1,151	38.4
3	9	15	27	85	212	144	240	299	1,007	67.1
	10	20	95	160	206	174	264	351	1,251	62.6
	11	25	92	176	226	185	326	390	1,395	55.8
	12	30	6	116	250	162	344	349	1,227	40.9
4	13	15	47	109	189	163	212	296	1,016	67.8
	14	20	60	158	188	177	277	295	1,155	57.8
	15	25	72	153	190	76	395	433	1,319	52.8

The following table gives the total number of eggs produced in all of the pens containing the same number of hens, and the average yield of eggs per bird.

EGG YIELDS WHEN ALL PENS CONTAINING THE SAME NUMBER OF BIRDS ARE COMBINED.

45 *birds, 15 in each pen gave 2,929 eggs. Per bird, 65.1.
80 birds, 20 in each pen gave 4,830 eggs. Per bird, 60.4.
100 birds, 25 in each pen gave 5,136 eggs. Per bird, 51.4.
90 birds, 30 in each pen gave 3,612 eggs. Per bird, 40.1.

The table which follows shows the most profitable number of hens in a flock in these experiments.

* The April hatched birds in Pen 1 not included in this table.

AVERAGE NUMBER AND ESTIMATED NET PROFIT FROM HENS IN FLOCKS OF 15, 20, 25, 30 BIRDS COMPARED.

Number of hens in each pen.	Number of eggs produced by each hen.	Number of eggs produced in each pen.	Value of eggs produced in each pen at 2 cents each.	Value of food used in each pen at average of 50 cents per bird.	Income from each pen less cost of food.
*15	65.1	976	$19.52	$7.50	$12.02
20	60.4	1,208	24.16	10.00	14.16
25	51.4	1,284	25.64	12.50	13.14
30	40.1	1,203	24.06	15.00	9.06

* The April hatched hens in Pen 1 are not included in this table.

From the above table it will be observed that pens containing twenty birds did not give as much profit per bird as did pens of fifteen birds, but the pens containing twenty birds gave a greater total net profit per pen than did those containing any greater or less number of birds. Pens with twenty-five birds gave slightly greater net returns than did the fifteen bird pens. The pens that had thirty birds each gave very much less net returns than did any of the others.

These tests show that when twenty birds were confined on one hundred and sixty feet floor space, they yielded more profit than did fifteen birds when kept in a similar room. This is a matter of considerable consequence, for the cost of buildings, for the proper housing of birds during the cold winters of our climate is the greatest item of expense to which the poultryman is subjected.

HERD RECORDS.

G. M. Gowell.

In the Station report for 1897, statements were given of the yields of milk, fat and butter from each cow in the herd for the year. As stated there, the purpose was to add to the limited data so far accumulated bearing upon: the ratio of the decrease of the milk flow from the time the cow is fresh until she is dry; the changes of the per cent of fat from month to month; and the milk and fat yields during the months following the act of breeding.

During 1898 there were twenty-four cows and heifers in the herd. As the animals are valuable for breeding purposes, they were fed such quantities and qualities of foods as seemed best for their welfare. The feeding has been with reference to individual needs for the production of moderate quantities of milk rather than forcing for large quantities.

From January first until June the animals of large capacities received each day about fourteen pounds of hay, composed of timothy, red top and alsike clover, and twenty-five pounds of corn silage, turnips or mangolds, in connection with eight pounds of concentrated food, consisting of equal weights of wheat bran, corn meal, and gluten or cottonseed meal, mixed together.

They were at pasture during June, July, August and part of September. During the remainder of the year they were kept in the barn and yards and fed as during the winter. Every night throughout the summer they were put in the barn and fed green oats, peas, corn or dry hay and silage when the grass in the pastures was not sufficient for their needs. About the same grain ration was given in the summer as in winter. Cows of smaller capacities received less feed, and heifers, even if well developed, were given diminished quantities of grain.

Animals when dry, or nearly so, received bran only as concentrated feed. By comparison with the records of last year it will be noticed tht certain cows yielded less this year than then. This is mostly accounted for by the difficulty in getting them to breed regularly which made them strippers a greater proportion of the year than in 1897. Discussion of these data will not be undertaken until more results are secured and tabulated.

MADALENE.—Holstein and Jersey. Nine years old. Calved April 4, 1898—due to calve March 14, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	....	....	....	....
February	....	....	....	....
March	....	....	....	....
April	870.0	4.0	34.80	40.60
May	936.0	4.2	39.31	45.86
June	852.0	4.3	36.63	42.73
July	792.0	4.8	38.01	44.34
August	666.0	4.2	27.97	32.63
September	578.0	3.8	21.96	25.62
October	382.0	4.0	15.28	17.82
November	310.0	4.0	12.40	14.46
December	....	....	....	....
	5,386.0		226.36	264.06

HUNTOON.—Holstein—full blood—not registered. Ten years old. Calved February 1, 1897, and October 16, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	616.5	4.4	27.12	31.64
February	642.0	4.0	25.68	29.96
March	586.0	4.5	26.37	30.76
April	528.0	5.3	27.98	32.64
May	527.0	4.8	25.29	29.50
June	510.0	4.4	22.44	26.18
July	486.0	4.7	22.84	26.64
August	266.0	5.2	13.86	16.13
September	....	....	....	....
October	601.0	4.0	24.04	28.04
November	1,050.0	3.7	38.85	44.32
December	897.0	3.6	32.29	37.67
	6,709.5		286.73	333.48

KATRINA.—Holstein Registry. Two years old. Calved February 20, 1899. Out of herd December 1, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	....	....	....	....
February	108.0	3.4	3.67	4.28
March	751.0	3.5	26.28	30.66
April	689.0	3.3	22.73	26.51
May	646.0	3.4	21.96	25.62
June	630.0	3.7	23.31	27.19
July	642.0	3.5	22.47	26.21
August	517.0	3.3	17.06	19.90
September	506.0	3.4	17.20	20.06
October	481.0	4.6	22.12	25.80
November	420.0	3.8	15.96	18.62
December	....	....	....	....
	6,390.0		192.76	224.85

CHESTER.—Grade Holstein. Six years old. Calved May 6, 1898—due to calve April 21, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	477.6	5.1	24.35	28.40
February	418.0	4.5	18.81	21.94
March	328.0	4.7	15.41	17.97
April	149.0	4.6	6.85	7.99
May	475.0	4.8	22.80	26.60
June	690.0	4.5	21.05	24.55
July	661.0	3.5	23.13	26.98
August	504.0	4.9	24.69	28.80
September	484.0	4.4	21.29	24.83
October	420.0	5.7	23.94	27.93
November	430.0	4.3	18.49	21.57
December	420.0	5.8	24.36	28.37
	5,456.6		245.17	285.93

FATAMIE.—Holstein—not registered. Eight years old. Calved May 27, 1898—due to calve April 19, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	400.6	3.6	14.42	16.82
February	335.0	3.8	12.53	14.61
March	154.0	3.8	5.85	6.82
April	....	....	....	....
May	151.0	3.6	5.43	6.33
June	1,058.0	3.8	40.20	46.90
July	1,130.0	3.0	33.90	39.55
August	837.0	3.2	26.78	31.24
September	992.0	3.0	29.76	34.72
October	752.0	4.0	30.08	35.09
November	730.0	3.3	24.09	28.10
December	651.0	4.5	29.29	34.17
	7,190.6		252.33	294.35

MARIE.—No. 3434 M. S. J. H. Book. Two years old April 4, 1898. Calved March 17, 1898—due to calve March 12, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	....	....	....	....
February	....	....	....	....
March	151.0	4.0	6.04	7.04
April	530.0	4.6	24.38	28.44
May	558.0	4.4	24.53	28.61
June	550.0	4.1	22.55	26.30
July	472.0	4.4	20.76	24.22
August	189.0	4.4	8.31	9.69
September	274.0	4.3	11.78	13.74
October	234.0	5.2	12.16	14.18
November	210.0	4.3	9.03	10.53
December	201.0	5.0	10.05	11.72
	3,369.0		149.59	174.47

PANSY.—Jersey—not registered. Eight years old. Calved April 9, 1898 and due to calve April 1, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	99.0	4.2	4.15	4.86
February	....	....	....	....
March	....	....	....	....
April	503.0	4.2	21.12	24.64
May	754.0	4.4	33.17	38.70
June	720.0	5.0	36.00	42.00
July	732.0	4.6	33.67	39.28
August	571.0	4.5	25.69	29.97
September	576.0	4.5	25.92	30.24
October	482.0	5.8	27.95	32.61
November	435.0	5.8	25.23	29.43
December	356.0	5.7	20.29	23.67
	6,119.0		253.19	295.38

ORLETTA.—No. 1734, M. S. J. H. Book. Eleven years old. Calved November 6, 1897—due to calve April 30, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	626.8	4.6	28.83	33.63
February	590.0	4.4	25.96	29.28
March	531.0	4.7	24.95	29.11
April	488.0	5.3	25.86	30.17
May	514.0	5.3	27.24	31.78
June	495.0	5.3	26.23	30.60
July	544.0	5.4	29.37	34.27
August	644.0	4.3	27.69	32.30
September	468.0	4.8	22.46	26.20
October	423.0	5.3	22.41	26.15
November	390.0	6.3	24.57	28.56
December	390.0	5.5	21.45	25.02
	6,043.8		306.99	357.07

TULIP.—No. 2501 M. S. J. H. Book. Six years old. Calved Jan. 31, 1898 and due to calve April 1, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	....	....	....	....
February	826.0	4.9	40.47	47.21
March	957.0	5.0	47.85	55.82
April	793.0	5.2	41.23	48.10
May	790.0	5.1	40.29	47.00
June	660.0	5.0	33.00	38.50
July	612.0	4.4	26.92	31.40
August	490.0	5.1	24.99	29.15
September	499.0	4.8	23.95	27.94
October	442.0	6.0	26.52	30.94
November	401.0	6.0	24.06	28.07
December	400.0	5.6	22.40	26.13
	6,870.0		351.72	410.34

RUTH.—No. 2369 M. S. J. H. Book. Six years old. Calved December 4, 1897 and October 28, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter. lbs.
January	840.2	4.2	35.62	41.56
February	811.0	4.1	33.25	38.79
March	722.0	4.3	31.04	36.21
April	675.0	4.2	28.35	33.07
May	620.0	4.4	27.28	31.82
June	585.0	4.9	28.66	33.44
July	504.0	4.8	24.19	28.22
August	352.0	5.2	18.30	21.35
September				
October				
November	930.0	4.4	40.92	47.74
December	938.0	4.3	40.33	47.05
	6,885.2		307.94	359.25

CHERRY 2d.—No. 3030 M. S. J. H. B. Six years old. Calved February 9, 1898, due to calve April 15, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	271.1	6.2	16.80	19.60
February	283.0	5.6	15.84	18.48
March	528.0	5.3	27.98	32.64
April	458.0	5.5	25.19	29.38
May	430.0	5.3	22.79	26.58
June	460.0	5.2	23.92	27.90
July	459.0	4.6	22.11	25.79
August	409.0	5.0	20.45	23.85
September	436.0	4.2	18.31	21.36
October	360.0	6.0	21.60	25.20
November	320.0	5.2	16.64	19.41
December	341.0	5.2	17.73	20.68
	4,755.1		249.36	290.87

LOBLITOP.—No. 1874 M. S. J. H. Book. Eleven years old. Calved October 14, 1897 and December 30, 1899.

1899.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	518.8	4.6	23.86	27.83
February	545.0	4.4	23.98	27.97
March	447.0	4.4	19.66	22.93
April	584.0	4.3	25.11	29.29
May	580.0	4.4	25.52	29.77
June	585.0	5.2	30.42	35.49
July	616.0	4.0	24.64	28.74
August	481.0	4.3	20.68	24.12
September	513.0	4.0	20.52	23.94
October	440.0	5.8	25.52	29.77
November	480.0	5.6	32.48	37.89
December	465.0	5.2	24.18	28.21
	6,254.8		296.57	345.95

BUTTERCUP.—Jersey—full blood—not registered. Six years old. Calved May 26, 1898—due to calve April 15, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	500.2	6.2	31.01	36.17
February	458.0	6.0	27.48	32.06
March	400.0	6.2	24.80	28.93
April	328.0	6.2	20.33	23.71
May	68.0	5.8	3.94	4.59
June	568.0	5.1	29.98	34.97
July	833.0	4.4	36.65	42.75
August	630.0	4.9	30.87	35.99
September	567.0	4.8	27.01	31.51
October	486.0	6.6	32.07	37.41
November	511.0	5.6	28.61	33.37
December	490.0	6.4	31.36	36.58
	5,862.0		324.11	378.04

CHERRY.—No. 3029 M. S. J. H. Book. Nine years old. Calved August 20, 1897—due to calve November 12, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	347.5	5.2	18.07	21.08
February	345.0	5.1	17.59	20.52
March	349.0	5.0	17.45	20.35
April	280.0	5.8	16.24	18.94
May	311.0	5.7	17.62	20.55
June	377.0	5.6	21.11	24.96
July	338.0	5.4	18.25	21.29
August	328.0	5.0	16.40	19.13
September	346.0	4.4	15.22	17.75
October	297.0	6.3	18.71	21.82
November	320.0	5.2	16.64	19.41
December	310.0	5.9	18.29	21.33
	3,948.5		211.59	247.13

ROSE—No. 1802 M. S. J. H. Book. Eleven years old. Calved November 16, 1897 and due to calve March 20, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	505.6	4.6	23.25	27.12
February	495.0	4.6	22.77	26.56
March	476.0	5.0	23.80	27.76
April	591.0	4.9	28.95	33.77
May	486.0	5.1	24.78	28.91
June	505.0	5.0	25.25	29.45
July	567.0	4.4	24.94	29.09
August	486.0	4.9	23.81	27.77
September	441.0	4.2	18.52	21.60
October	370.0	5.7	21.09	24.93
November	380.0	4.9	18.62	21.72
December	387.0	5.5	21.28	25.16
	5,740.6		277.06	323.84

HOPE—No. 2368 M. S. J. H. Book. Seven years old. Calved October 28, 1897, and due to calve March 16, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	568.1	5.0	28.45	33.13
February	503.0	4.6	23.13	26.98
March	466.0	5.4	25.16	29.35
April	425.0	5.7	24.12	28.14
May	291.0	5.6	16.29	18.99
June	475.0	5.3	25.17	29.36
July	472.0	6.7	31.62	36.89
August	360.0	5.1	18.36	21.42
September	396.0	4.4	17.42	20.32
October	283.0	5.5	15.56	18.15
November	242.0	5.2	12.58	14.67
December	170.0	6.2	10.54	12.29
	4,651.1		248.40	289.69

ADLE—Jersey—High grade. Five years old. Calved May 12, 1898, due to calve May 10, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	245.5	6.0	14.79	17.25
February	137.0	5.6	7.67	8.94
March	....	....	....	....
April	....	....	....	....
May	453.0	5.0	22.65	26.42
June	810.0	5.1	41.31	48.19
July	769.0	5.2	40.68	47.46
August	661.0	4.3	28.42	33.15
September	569.0	5.0	28.45	33.19
October	530.0	6.8	36.04	42.04
November	480.0	5.2	24.96	29.12
December	456.0	6.1	27.81	32.44
	5,111.5		272.78	318.20

LOTTIE.—No. 1751, M. S. J. H. Book. Eleven years old. Calved October 31, 1896, and October 14, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	322.9	6.4	20.66	24.10
February	297.0	6.0	17.82	20.79
March	312.0	6.2	19.34	22.56
April	307.0	6.5	19.95	23.27
May	219.0	6.0	13.14	15.33
June	180.0	6.2	11.16	13.02
July	171.0	5.0	8.55	9.97
August	....	....	....	....
September	....	....	....	....
October	448.0	5.0	22.40	26.32
November	740.0	4.0	29.60	34.53
December	660.0	5.0	33.00	38.50
	3,656.9		195.62	229.39

DUDLEY.—Jersey—High grade. Eight years old. Calved September 8, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	489.8	4.9	24.00	28.00
February	489.0	5.0	24.45	28.52
March	466.0	5.8	27.12	31.64
April	404.0	4.2	16.96	19.79
May	388.0	4.6	17.84	20.82
June	370.0	4.9	18.13	21.15
July	364.0	5.0	18.20	21.23
August	....	....	....	....
September	440.0	3.2	14.08	16.42
October	601.0	5.5	33.05	38.55
November	570.0	5.4	30.78	35.91
December	615.0	5.2	31.98	37.31
	5,196.8		256.59	299.34

TURNER.—Jersey—High grade. Eight years old. Calved October 21, 1897, due to calve April 9, 1899.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	606.9	4.4	26.70	31.15
February	533.0	3.4	18.12	21.14
March	511.0	4.6	23.50	27.41
April	405.0	3.4	13.77	16.06
May	435.0	4.0	17.40	20.30
June	450.0	4.4	19.80	23.10
July	441.0	3.6	15.87	18.51
August	256.0	4.7	12.03	14.03
September	270.0	3.6	9.72	11.34
October	210.0	3.3	6.93	8.08
November	80.0	3.0	2.40	2.80
December	....	....	....	....
	4,197.9		166.24	193.92

LOWELL.—Native. Ten years old. Calved September 10, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	545.7	4.6	25.10	29.28
February	533.0	3.1	16.52	19.27
March	510.0	5.0	25 50	29.75
April	476.0	4.8	22.84	26.64
May	423.0	5.0	21.15	24.47
June	390.0	5.2	20.28	22.66
July	365.0	3.5	12.77	14.89
August	......	......	......	......
September	600.0	3.5	21.00	24.05
October	820.0	4.4	36 08	42.09
November	720.0	4.0	28.80	33.60
December	700.0	4.8	33.60	39.20
	6,082.7		263.84	306.90

FERRY.—Native. Eight years old. Calved September 20, 1897.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	477.2	4.4	20.99	24.48
February	486.0	4.2	20.41	23.81
March	498.0	4.0	19.92	23.24
April	456.0	4.6	20.97	24.46
May	404.0	4.5	18.18	21.21
June	385.0	4.7	18.09	21.10
July	427.0	4.3	18.36	21.42
August	387.0	4.4	17.02	19.85
September. (Sold Sept. 1st)	......	......	......	......
October	......	......	......	......
November	......	......	......	......
December	......	......	......	......
	3,520.2		153.94	179.57

LINCOLN.—Native. Seven years old. Calved October, 1898.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	613.3	4.5	27.59	32.18
February	676.0	4.4	30.42	35.49
March	657.0	4.8	31.53	36.78
April	623.0	4.9	30.52	35.60
May	594.0	5.0	29.70	34.65
June	577.0	5.2	29.90	34.88
July	420.0	4.9	20.58	24.01
August	248.0	4.9	12.15	14.17
September	......	......	......	......
October	501.0	4.9	24.54	28.63
November	725.0	4.0	29.00	33.83
December	808.0	4.6	37.16	43.35
	6,441.3		303.09	353.57

TOPSEY.—Native. Two years old in February, 1898. Calved December 1, 1897.

1898.	Milk—lbs.	Per cent fat.	Fat—lbs.	Butter—lbs.
January	607.0	4.6	27.92	32.57
February	603.0	3.8	22.91	26.72
March	654.0	4.4	28.77	33.56
April	523.0	4.0	20.92	24.40
May	476.0	4.3	20.46	23.87
June	530.0	4.5	23.85	27.82
July	478.0	4.2	20.07	23.41
August	382.0	4.3	16.42	19.15
September	239.0	4.5	10.75	12.54
October	....	....	....	....
November	....	....	....	....
December	....	....	....	....
	4,492.0		192.07	228.04

A COMPARISON OF LARGE AND SMALL RADISH SEED.

W. M. MUNSON and L. J. SHEPARD.

In the spring of 1898 one of the students in horticulture, Mr. E. R. Mansfield, in studying the influence of the size of seed upon germination, obtained some very striking results. These results confirm the work of previous years and are in line with those published by Galloway and others,* but the details may be of interest at this time.

First Trial: From a packet of Scarlet Globe Radish seed were chosen one hundred of the smallest seeds, as nearly uniform in size as possible; likewise one hundred uniformly large seed. These were planted side by side in a seed-flat. When the resulting plants were about two to three inches high, forty-four average plants from each lot were transplanted to a bench where they grew, under like conditions, till maturity.

The following table shows concisely the results obtained:

YIELD OF RADISHES FROM LARGE AND SMALL SEEDS COMPARED.

Size of seed.	Number of plants.	Total weight, grams.	Number of first-class roots.	Number of second-class roots.	Per cent first-class roots.	Per cent second-class roots.	Per cent unmarketable.
Large	44	1,300	**35**	7	**79.6**	15.9	4.5
Small..................	44	931	**22**	17	**50.0**	38.6	11.4

The number of first-class roots from the large seed was about thirty per cent greater than from the small, while the weight of the crop exceeded the other by about one-third.

* Year Book, U. S. Dept. of Ag. 1896, pp. 92, and 305.

Second Trial: The difference in favor of the selected large seeds in the first trial was so striking that the work was repeated upon a larger scale the present year. The variety chosen for this purpose was "Non Plus Ultra," an early turnip-shaped sort which we have found specially good for forcing. The seeds were sown in six rows and at the end of two weeks the plants were thinned to eighteen in each row. Owing to the dark weather, many of these plants "damped off" after the thinning, hence a difference in the numbers, considered in the table. The following results were obtained:

Number of seeds planted, 300 each, large and small. Weight of large seed, 4.19 grams. Weight of small seed, 1.78 grams. Time from planting to harvesting, seven weeks. Temperature of house, 45°-60°.

YIELD OF RADISHES FROM LARGE AND SMALL SEEDS COMPARED.

Size.	Total germination.	Number of plants considered.	Number of first-class roots.	Number of second-class roots.	Number of culls.	Per cent of first-class by number.	Per cent of first-class by weight.
Large	196	87	55	22	10	**63.2**	**71.4**
Small	197	98	13	75	10	***13.2**	**15 9**

*The very low percentage of first-class roots is due to immaturity, rather than to other inferiority.

There was practically no difference in the total germination of the two lots, though in both cases the per cent of germination was low. At the time of harvesting there were sixty-three per cent of the roots, from large seed which were strictly first-class, as opposed to thirteen per cent from the small seed.

Third Trial: At the same time that the preceding work was being carried on, another lot of seed, of both sizes, was planted upon a bench which was used for testing the value of sub-watering. As before there was some trouble with damping off after the plants were thinned. The results are detailed below:

Number of seeds of each kind 200. Weight of large seed 2.8 grams. Weight of small' seed 1.2 grams. Time from planting to harvesting, seven weeks. Temperature of house, 45°-60°.

YIELD OF RADISHES FROM LARGE AND SMALL SEEDS COMPARED.

Size.	Total germination.	Total number of plants used.	Number of first-class roots.	Number of second-class roots.	Weight of first-class roots —Grams.	Weight of second-class roots —Grams.	Per cent of first-class roots by number.	Per cent of first-class roots (by weight.)
Large	127	62	49	13	714	112	**79.0**	**86.5**
Small	132	65	33	32	336	238	**50.8**	**58.5**

As in the previous instance, the percentage of germination was low (sixty-three per cent), but was about uniform in the two lots. The number of first-class roots from the large seed exceeded that from the small seed by about twenty-eight per cent. In weight about the same difference was obtained.

Conclusions: From the above, it is evident that plants from large seed grow larger and mature earlier, than those from small seed. Inasmuch as the cost of seed is slight as compared with the cost of labor and fuel, and in view of the importance of having the crop ready for market in the shortest possible time, the gardener can well afford to sift the seed before planting and discard all which is small and inferior. For the purpose of sifting, common wire cloth which is used for window screens (1-12 inch mesh) will answer; though a screen with 1-10 inch mesh is better, as many of the small seeds will not readily pass through the window screen.

THE EFFECT OF SUB-WATERING RADISHES.

W. M. MUNSON and L. J. SHEPARD.

Much has been said and written upon the subject of "sub-watering" or "sub-irrigation" in greenhouses. The present paper simply details the experience of the writers in growing radishes by the new method and by the ordinary method of surface watering.

The method usually employed, in sub-watering greenhouse benches, is to provide a water-tight bottom and run one or more lines of tile or perforated iron pipe underneath the soil. The method employed in the first trial noted below was suggested by Professor Woods, and consists of a line of 2-inch drain pipe, cemented at the joints and closed at the ends, as seen in the cut. The water for the soil must pass through the porous sides of the tile.

First Trial: A quantity of seeds carefully selected as to size and quality, were planted on the lower bench in the house devoted to lettuce and radishes. When the plants were two weeks old they were thinned to about 1½ inches. After thinning, some of the plants damped off, so that the total number in the two lots is not the same. The percentages, however, are not affected.

The following table shows concisely the results obtained:

YIELD OF RADISHES FROM SUB-WATERED AND SURFACE-WATERED BENCHES COMPARED.

Treatment.	Per cent of germination.	Number of plants used.	Number of first-class roots.	Number of second-class roots.	Number of culls.	Per cent first-class by number.	Per cent first-class by weight.
Sub-watered	63.5	62	49	13	....	**79**	**86.4**
Surface-watered ..	65.3	87	55	22	10	**63**	**71.9**

There was little difference in the per cent of germination in the two lots; but the plants which were sub-watered were superior to the others from the beginning. At the time of harvesting, the number of first-class roots on the sub-watered section exceeded that on the surface watered section by 15%; while the average weight was 14.5% greater. This difference is plainly shown in the accompanying figure.

Second Trial: A second bench in the radish house was divided into two sections, and the advantage of sub-watering was demonstrated on a commercial scale. In this instance, the arrangement for sub-watering was somewhat different than in the previous one. The bottom and sides of the bed were coated with Portland cement. On this was placed about two inches of potsherds and broken brick, and then, after covering the brick with some pieces of burlaps, the soil was put in place. As the soil became dry, water was admitted through a pipe to the stratum of potsherds. A glass indicator served to show the height of the water. Each section of the bench was fourteen feet eight inches long and twenty-eight inches wide. The seed was planted in rows, eight inches apart, between rows of lettuce,—twenty-two rows in each lot.

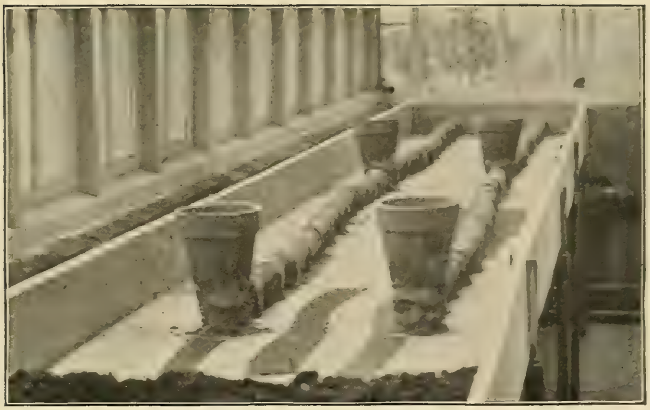
There was little difference in germination of the two lots, but very many more plants were lost by damping off on the surface-watered section,—a fact that partly accounts for the difference in yield at harvest time.

The results at harvest were as follows:

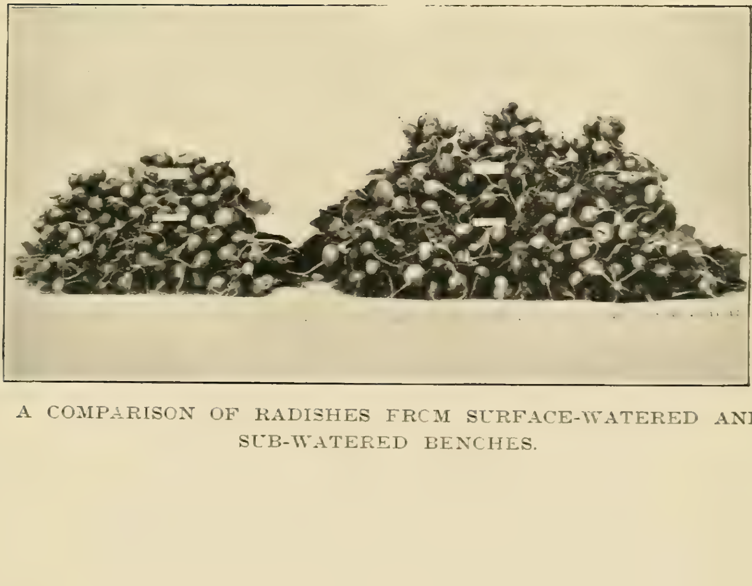
YIELD OF RADISHES FROM SUB-WATERED AND SURFACE-WATERED BENCHES COMPARED.

Treatment.	Number of bunches marketable.	Number of roots marketable.	Number of roots, second class and culls.*	Weight of marketable roots.	Weight of second class and culls.	Per cent marketable.
				Grams.	Grams.	
Sub-watered	28	212	242	3,752	2,590	**46.7**
Surface-watered	13	118	228	1,498	1,750	**34.1**

*The reason for the very high percentage of "second class and culls" is explained in the next table.



GREENHOUSE BENCH ARRANGED FOR SUB-WATERING.



A COMPARISON OF RADISHES FROM SURFACE-WATERED AND SUB-WATERED BENCHES.

The sub-watered section yielded twice as many bunches of marketable roots as did the other. The per cent of marketable roots was much higher and the average size greater from the sub-watered section. The difference in the yield of the two sections was more than enough to make the difference between profit and loss in growing the crop.

As will be observed from the above table, more than half of the roots are classified as "2d-class and culls." It should be said in explanation, that about half of the number so classed were simply of small size; many of them were inferior or diseased; others were of good size and quality, but badly disfigured by attacks of millipedes. The following table shows the relative difference in this respect:

QUALITY OF RADISHES FROM SUB-WATERED AND SURFACE-WATERED BENCHES COMPARED.

Treatment.	Marketable.	Second size.	Injured by millipedes.	Diseased.	Inferior.
Sub-watered:					
Number	212	119	77	6	63
Weight (in grams)	3,752	1,232	1,043	70	245
Surface-watered:					
Number	118	117	12	22	83
Weight (in grams)	1,498	1,008	112	224	406

The number of roots attacked by millipedes was much greater on the sub-watered section—a significant fact in connection with the control of this pest. It is also seen that the number of diseased and inferior roots was much larger on the surface-watered section. This, together with the fact previously noted, that there was much more trouble from "damping off" on this section is also significant. The injured roots were mostly of marketable size but deformed, as shown in fig. 8, following p. 229.

THE BLUEBERRY IN MAINE.

W. M. Munson.

Authors have not made a very clear discrimination in the vernacular names of the plants variously known as huckleberries and blueberries. In New England, however, the term blueberry is generally applied to various species of Vaccinium,—particularly *Vaccinium Pennsylvanicum,* Lam., *V. vacillans,* Solander, and *V. Canadense,* Kalm, which are not separated when harvested for market. *V. corymbosum,* L., is known as high bush blueberry. Huckleberry, on the other hand, usually refers to species of Gaylussacia in which the seeds are large and prominent—particularly *G. dumosa* T. & G. and *G. resinosa,* T. & G. The terms whortleberry and bilberry, which are given prominence in American references to plants of this class, are never heard among the "common people." The word huckleberry does not occur in English works except those of recent date, and there is no satisfactory explanation of the origin of the word.*

SPECIES FOUND ON THE BARRENS.

In the summer of 1898, in company with Professor Harvey, the writer made an extended visit to the blueberry fields in the vicinity of Cherryfield for the purpose of studying the different types found there. The following brief account of the species found may be of interest in this connection:

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* The term huckleberry is, according to W. R. Gerard (*Trans. Mass. Hort. Society*, 1890, p. 17), merely a corruption by the American colonists of hurtleberry, which is simply a changed pronunciation of whortleberry, which again is a corruption of myrtleberry (from *Vaccinium myrtillus*). The corruption from hurtleberry is very easy by dropping the first *r*, *i. e.* hutleberry. Others derive the name whortleberry from the Anglo Saxon *heort-berg*, hart-berry, or as we would say deer-berry. The question is discussed by Dr. E. Lewis Sturtevant, in the Transactions of the Massachusetts Horticultural Society, 1890, p. 18.

DWARF OR LOW-BUSH BLUEBERRY.

1. *Vaccinium Pennsylvanicum,* Lam.

(*Vaccinium Pennsylvanicum,* Lam. Dict., 1, 72; Michx, Fl., 1, 223; Hook, Bot. Mag., t. 3434; Gray, Man. 6 ed., 312; Syn. Fl., 2., 1, 22. *Synonym, Vaccinium myrtilloides,* Michx, l. c.; *V. tenellum,* Pursch, Fl. 1, 288, not Ait.; Bigel., Fl. Bost., 150.)

A low branching shrub, 6 inches to 2 feet high, with green, warty but glabrous branches. Leaves oblong, or oblong-lanceolate, green and glabrous on both sides or slightly pubescent on the veins beneath, sharply serrulate, acute at both ends, ¾ to 1½ inches long, ¼ to ½ inch wide; flowers few in the clusters, longer than the very short pedicels; corolla oblong-campanulate, slightly restricted at the throat, white or pinkish; berry blue with more or less bloom, very sweet, ripening in July. Found mostly on dry, rocky or sandy soil.

This species, commonly known as "Early Sweet" or "Low Sweet," furnishes the greater part of the blueberries of our market. The fruit is usually large, sweet, bluish-black and covered with bloom. It varies greatly, however, in size, form and color. The plant is of low habit and, on newly burned areas, is very prolific. (Fig. 1 shows a blueberry carpet of this species.) Old plants bear but few flowers or fruits in a cluster, as already intimated, but plants one or two years from the "burn," usually send up a prominent spike, as shown in fig. 3. The berries can thus be stripped off by the handful and gathered very rapidly.

2. *Vaccinium vacillans,* Solander.

A low, stiff, branching shrub with glabrous, warty, yellowish-green branches; leaves obovate or oval, entire or minutely serrulate, pale, glabrous on both sides or often glaucus beneath; flowers bell-shaped or cylindrical, somewhat constricted at the throat, pink. Dry places, especially in sandy soil. May-June. Fruit ripe, July, August.

This species, often associated with *V. Pennsylvanicum,* is of excellent quality and ripens somewhat later than the other. As with *V. Pennsylvanicum,* the flowers are often racemose on long naked branches. The species was seldom met in the vicinity of Cherryfield, but is abundant in some parts of the State. It is deserving of attempts at cultivation.

LOW BLACK BLUEBERRY.

3. *Vaccinium nigrum*, Britton, (Mem. Torr. Club, 5; 252, 1894). (*Vaccinium Pennsylvanicum* var. *nigrum*, Wood.).

"Similar to *Vaccinium Pennsylvanicum* and often growing with it; 6 to 12 inches high, the twigs glabrous. Leaves oblong, oblanceolate or obovate, acute at apex, narrowed or rounded at the base, finely serrulate, very nearly sessile, ½ to 1 inch long, ¼ to ½ inch wide, glabrous on both sides, green above, pale and glaucus beneath; flowers few in the clusters, longer than their pedicels; corolla globose-ovoid, very little constricted at the throat, white or cream color; berry black, without bloom, about ¼ inch in diameter.—Blooms earlier than *V. Pennsylvanicum* May. Fruit ripens in July." Britton & Brown, Flora of North U. S. II, 579.

This type (fig. 5) is not infrequent in the vicinity of Cherryfield and is classed with the ordinary "Early Sweet." It is usually found in areas varying in extent from a few square feet to several rods. Scattering bushes are also found mingled with *V. Pennsylvanicum.*

VELVET LEAF OR "SOUR TOP."

4. *Vaccinium Canadense,* Richards. (Richards in Frank. Jour. 2, 12 (1893); Hook Fl., 2, 32; and Bot. Mag., t. 3446; Gray, Syn. Fl., 2, 1, 22). A low pubescent, branching shrub, 6 inches to 2 feet high. Leaves oblong, oblong-lanceolate or narrowly elliptic, pubescent, at least beneath, entire, 1 to 1½ inches long, ⅓ to ½ inch wide; flowers few, in clusters which are sometimes numerous on naked branches, appearing with the leaves; pedicels usually shorter than the flowers; corolla oblong-campanulate, greenish white; berry blue, with bloom (rarely white), moist places, May and June. Fruit ripe July and August.

This species, usually more vigorous in habit than the preceding, grows more commonly in rather moist, rocky, not swampy, localities. The firuit (fig. 4) is larger and more acid than the other low forms (hence the popular name "Sour Top"), and matures from one to three weeks later. It is not so popular in the general market as is the first mentioned species, but it is very prolific and its lateness in ripening is a point in its favor.

HIGH-BUSH BLUEBERRY.

5. *Vaccinium corymbosum,* L.

(*Vaccinium corymbosum* L. Sp. Pl. 350, 1753. *V. amœnum,* Ait., Hort., Kew. 2: 12. 1789).

Tall (5-10 feet), with minutely warty, greenish-brown branches; leaves ovate, oval or oblong, short petioled; flowers, appearing with the leaves, equal to or longer than the pedicels; corolla cylindrical or slightly constricted at the throat, white or pinkish; berry blue with a bloom. Exceedingly variable. Swamps and moist woods, often extending to dry hillsides.

This species is very variable, not only in the habit of growth, but in its blooming characters and fruit. Not infrequently individual plants bear large quantities of fruit measuring 3/8 to 5/8 inch in diameter, while a black fruited variety, (*var. atrococcum,* Gray), has small, polished, black fruits, equally as good as the other in flavor. The fact of variability renders this species one of the most promising for cultivation. It flourishes alike in the sunlight and in partial shade; on the dry upland and in the swamp. It is also worthy of note that plants of similar quality, both as to habit and size of fruit, are usually found associated in groups—a fact which indicates that these characteristics are probably transmitted by seed.

THE BLUEBERRY INDUSTRY.

The blueberry has been highly prized as an article of food from the earliest colonial period. Up to the present time, however, practically no attention has been given to the cultivation and systematic improvement of the fruit.

In many of the northern and eastern states there are thousands of acres of land, utterly worthless for agricultural purposes, which after the pine is removed, send up an abundant growth of blueberry bushes, alders, poplars, grey birches, etc., and which, by proper management may, it is believed, be made to yield a handsome profit to their owners.

In the southeastern part of Maine, principally in Washington county, there are about 150,000 acres known as the "blueberry barrens." This land lies chiefly in the townships of Cherryfield, Columbia, Deblois, Beddington, and Numbers 18 and 19. Much of this land was burned over by the Indians before the colonial

period and since the timber was removed from the remainder, it too, has been repeatedly burned to keep down the growth of birches, alders, etc. and to facilitate the harvesting of the fruit.

About 40,000 acres of the blueberry barrens belong to Mr. William Freeman of Cherryfield, to whom, and to his son, Mr. George G. Freeman, the writer is under obligation for many courtesies during his visits to the plains. Mr. Freeman's method of handling his blueberry lands may be taken as an example of what may be done in developing the industry in other sections. The plan is somewhat as follows:

The land is divided into several parts, each of which is leased to some responsible party who assumes the whole care of burning over the land, keeping off trespassers, harvesting and marketing the fruit. Mr. Freeman receives, as rental, one-half cent per quart for all the fruit gathered.

The pickers receive one and a half to three cents per quart; those who lease the land and haul the fruit to the canning factory, or to the station for shipment, one-half to one cent per quart. The fruit is all canned or shipped by J. & E. A. Wyman, who keep a record of the amount as it is brought in and pay the royalty to Mr. Freeman, retaining for themselves whatever profit there may be on the canned fruit.

Every year a certain section of each "lease" is burned over. This burning must be done very early in the spring, before the ground becomes dry; otherwise the fire goes too deep, the humus is burned from the ground and most of the bushes are killed. Many hundred acres on what should be the best part of the "barrens" have thus been ruined. The method most commonly used in burning a given area, is for the operator to pass around the section to be burned, dragging after him an ordinary torch or a mill-lamp. He then retraces his steps and follows over the burned area setting new fires in the portions which have escaped, and back-firing if there is danger of spreading unduly over areas which it is desired to leave unburned. A device which was found in use by one party consists of a piece of ½-inch gas-pipe bent at the end at an angle of about 60 degrees. The end opposite the bent portion is closed with a cap or a plug, and in the other end, after filling the pipe with kerosene, is placed a plug of cotton waste or tow. This device

is regarded as superior to the lamp or torch as it is more easily handled.

As already indicated, most of the fruit from the barrens is taken to the factories for canning. Early in the season, however, before the factories are opened, a considerable amount is shipped to Portland, Boston and other points for use while fresh. This fruit is usually shipped in quart boxes—shown in fig. 2.

All of this early fruit is picked by hand, and only the ripe fruit is gathered. Later in the season, particularly on "old burns," *i. e.,* on areas which will have to be burned over the next year, the fruit is gathered with a "blueberry rake." This is an implement somewhat similar to the cranberry rake in use on Cape Cod, and may be likened to a dust pan, the bottom of which is composed of stiff parallel wire rods. The fruit may be gathered much more quickly and more cheaply by means of the rake. The bushes are, however, seriously injured by the treatment. In no case should the rake be used in gathering the high bush blueberries.

The canning of blueberries is mainly in the hands of the following companies: J. & E. A. Wyman, Cherryfield; A. L. Stewart, Cherryfield; the Columbia Falls Packing Company, Columbia Falls; J. A. Coffin, Columbia Falls, and Burnham and Morrill, Harrington. At the Wyman cannery, which has a daily capacity of 600 bushels, the average annual output is about 8,300 cases of two dozen cans each; representing 6,250 bushels of fresh fruit. The average price per case for the canned fruit is $1.90. In other words, the value of the annual product of this one factory is more than $10,000. The total canned product of the blueberry barrens in 1898 was about 15,000 cases valued at about $28,500. This was but little more than one-half of the average season's production, which is said to be not far from 30,000 cases of twenty-four cans each.

POSSIBILITIES OF CULTURE.

The distribution of the blueberry is not confined to a few thousand acres in Washington county, but all over the southern and western parts of the State are vast areas which, while bearing a considerable number of bushes and yielding a profitable return to the few people who make a practice of gathering the

wild fruit, are not utilized as they might be. The systematic treatment already described, might, with profit, be extended to many parts of Franklin and Oxford counties as well.

There are also large areas, otherwise worthless, in the more hilly sections, even in close proximity to natural growth of blueberry bushes, which might, apparently, be made to yield good returns if in some way a growth of blueberries could be started—either by setting bushes or by scattering seed. With this end in view, arrangements were made in the spring of 1898, with F. J. D. Barnjam of Carrabassett, to procure 1,000 bushes from the neighboring hillsides and plant them in an old pasture where their development may be observed.

In August, 1897, while studying the types found upon the plains near Cherryfield, the writer selected numerous specially promising clumps of bushes of the several species, and later transferred them to the Station garden. These were given thorough culture during the past season, and have made a good growth. In August, 1898, more plants were selected, and in October they were removed to the Station and planted with the others. The two lots cover about one-eighth acre of land.

At the same time the bushes above mentioned were selected, a quantity of the largest and best fruit from the best bushes was gathered. This fruit was macerated and the seed sown with the hope of raising some superior seedlings. These will be grown in nursery rows and later transferred to the field.

In garden culture, but little has ever been done with the blueberry. That very satisfactory results might, however, be obtained, there is little doubt. The fruit in its wild state is far superior to that of many other cultivated plants.

As already noted, the work is still in its infancy at the Station. A few statements from others who have made the attempt in previous years, may, however, be of interest in this connection.

Edmund Hersey, Hingham, Mass.: "I have for many years been trying in a small way to find out what can be accomplished in growing the high bush blueberry. My conclusions are briefly: (1) It does not take kindly to garden cultivation; (2) it is very difficult to propagate from the seed; (3) it is somewhat difficult to graft; but patience and a little of the "know

FIG. 1. A BLUEBERRY CARPET.

FIG. 2. READY FOR SHIPMENT.

FIG. 3. *Vaccinium Pennsylvanicum*, L.

FIG. 4. *Vaccinium Canadense*, Richards.

FIG. 5. *Vaccinium nigrum*, Britton,

THREE LEADING TYPES OF BLUEBERRIES.

how" will overcome all of these. If grown in the garden (1) they must be on the north side of a board fence, or in the shade of trees, and the ground must be mulched with leaves, or evergreen boughs; (2) let the seed get fully ripe and drop, then sow in a moist shady place; (3) graft small bushes at the surface of the ground and cover most of the cion with moist earth. I have succeeded in all of the above."

W. D. Huntington, Lynn, Mass.: "I have been cultivating blueberries in a small way for home use, and as an interesting experiment, for ten or twelve years, and am fully convinced of the possibilities of the venture commercially. The variety I have succeeded best with is *V. Corymbosum,* carefully selected. My ground is a rocky, poor, upland soil, but the berries take on an improved look and size, and the bushes are loaded down with three or four times as much fruit as in the pastures or swamps, and are 25 or 30 per cent larger. I should set them six feet apart each way and give them clean culture. The plants are greatly benefited by a mulch of strawy manure placed around them in autumn and will not be injured by a large quantity.

"I have some seedlings in bearing, but they are not as good as the parent plant and I have not sufficient room to grow large quantities of them to get one rare plant. Have had many berries ½ to 9-16 inches in diameter and a few ⅝. I would not think a plant that did not have a few berries ½ inch in diameter, worth cultivating. Some of my plants have borne 12 quart boxes of berries in a season. These sold to our near neighbors at 20 cents per box and they always ask for more."

Benj. G. Smith, Cambridge, Mass.: "In an amateur way I have experimented with highbush blueberries for about twenty years. I secured some of the largest and finest high-bush blueberries I have ever seen and planted the seeds, a few of which vegetated the first year and more the second. I gave them personal attention and in three or four years they fruited and in a year or two more abundantly."

Mr. Smith found, as might be expected, that the seedlings were quite variable, and few of them were equal in size to the fruits from which the seed was taken. This variable character is, however, one of the hopeful indications for the future of this fruit.

SUMMARY.

1. In New England the term "Blueberry" is applied indiscriminately to various species of Vaccinium, particularly to *V. Pennsylvanicum,* Lam., *V. vacillans,* Solander, and *V. Canadense,* Kalm. *V. Corymbosum* L., is known as the high bush blueberry.

2. The species most commonly found are, in the order of their commercial importance, *Vaccinium Pennsylvanicum,* Lam., *V. Canadense,* Kalm., *V. corymbosum,* L., *V. nigrum,* Britton, and *V. vacillans,* Solander.

3. The "Blueberry Barrens" of Maine are mainly in Washington county and are about 150,000 acres in extent. There are, however, many thousand acres in other parts of the State that are, or might be made, profitable blueberry lands.

4. Blueberry lands that are treated systematically are usually burned over every third year for the purpose of renewing the bushes and of checking the growth of the alders, birches, etc. Lands bearing the high bush blueberry are seldom burned over.

5. The Station is now making an effort to introduce several species into cultivation. This is done by transferring some of the most productive and largest fruited plants to the garden, and by growing seedlings from selected fruit.

6. The few attempts that have been made at garden culture of the blueberry, indicate that, with care, satisfactory results may be obtained.

EXPERIMENTS UPON THE DIGESTIBILITY OF BREAD WITH MEN.

Chas. D. Woods and L. H. Merrill.

In coöperation with the Nutrition Division of the United States Department of Agriculture, this Station is making investigations upon the nutritive value of wheat. While much study has been given to this interesting field, very few results have been obtained which are applicable to the conditions common in this country. The European investigations have been made with flours different from those in common use in America and the breads have been made by methods unknown to bakers in this land. The studies here reported are only a part of an investigation undertaken with the hope of accumulating data which shall serve to answer the numerous questions arising as to the effect of milling upon the nutritive value of the resulting flours. The full account of these investigations will be given at a later time in publications of the U. S. Department of Agriculture. In the following pages there are given the results of the experiments on the digestibility of different kinds of wheat flours.

Analyses of Foods and Feces.

The bread reserved for analysis was sliced and dried at a temperature of about 60° C. The feces were dried on the tins upon which they were deposited at 60° C. After removal from the drying closets, the samples were allowed to stand for two days exposed to the air of the sampling room. They were then broken up in a mortar, ground in a mill so as to pass through a sieve with round holes one-half millimeter in diameter, and bottled for analysis.

Methods of Analyses.—These were the official methods of the Association of Official Agricultural Chemists. In the ash determinations of the flour and bread, it was found necessary to exhaust the charred mass with hot water before the incinera-

tion could be completed. The ether extraction of the feces was accomplished with considerable difficulty, the results not being regarded as wholly satisfactory.

Heats of Combustion.—The heats of combustion of the food, feces and urine were determined by burning in the bomb calorimeter. The milk and urine were prepared for burning in the following manner: A weighed filter block, previously dried for two days over sulphuric acid, was placed in a platinum capsule and saturated with the milk or urine. A second weighing gave the amount of the fluid added. The block was then placed in a drying oven and dried at a temperature not exceeding 70° C. It was again saturated and dried. The burning was accomplished in the usual manner, the fuel value of the filter block itself, previously determined by burning similar blocks, being deducted from the result.

Description of Breads.—Nos. 6,001-6,006. White bread made from Pillsbury's Best Flour and raised with yeast from the following recipe: Flour 900 grams, salt 12 grams, sugar 18 grams, lard 23 grams.

No. 6,007. Bread from bakery, made from Washburn's best flour, with yeast.

Nos. 6,034-6,037. Graham bread made from ground No. 1 winter wheat and raised with baking powder, as follows: Flour 1,462 grams, sugar 90 grams, salt 50 grams, baking powder 32 grams.

Nos. 6,047-6,049. Entire wheat bread made from Franklin Mills entire wheat flour, and raised with baking powder, the same as Nos. 6,034-6,037.

Nos. 6,064, 6,065, 6,077, 6,078, 6,120. White bread made from Pillsbury's Best Flour. It was raised with yeast and was of excellent quality.

Nos. 6,086 and 6,087. Entire wheat bread made from Franklin Mills entire wheat flour, with yeast. No white flour was used.

Nos. 6,097 and 6,098. Graham bread made with yeast, without addition of white flour, from a locally ground white winter wheat graham flour.

The results of the analysis follow:

PERCENTAGE COMPOSITION AND HEATS OF COMBUSTION PER GRAM OF FOOD MATERIALS, CALCULATED TO WATER CONTENT AT TIMES THEY WERE USED IN THE DIGESTION EXPERIMENTS HERE REPORTED.

Laboratory Number.	Number Experiment.	Material.	Water.	Nitrogen.	Protein.	Fat.	Carbo-hydrates.	Ash.	Heats of combustion. Determined.
			%	%	%	%	%	%	Cal.
6001..	1	White bread	36.06	1.40	8.78	1.73	52.73	.70	2,841
6002..	2	White bread	34.48	1.39	8.68	1.68	54.42	.74	2,938
6003..	3	White bread	34.68	1.39	8.68	1.91	53.42	1.30	2,926
6004..	4	White bread	34.10	1.40	8.73	1.74	54.04	1.39	2,938
6005..	5	White bread	34.07	1.36	8.51	2.98	52.46	1.98	2,943
6006..	6	White bread	33.35	1.37	8.59	2.23	53.90	1.93	2,960
6007..	7-8	White bread	38.51	1.52	9.50	.81	50.42	.76	2,698
6034..	9	Graham bread	28.17	1.62	10.11	1.28	57.42	3.02	3,032
6035..	10	Graham bread	41.92	1.32	8.24	1.05	46.85	1.94	2,476
6036..	11	Graham bread	51.81	1.08	6.76	.90	38.61	1.92	2,049
6037..	12	Graham bread	42.39	1.26	7.86	1.16	46.55	2.04	2,456
6047..	13	Entire wheat bread	42.22	1.35	8.45	.42	47.07	1.84	2,467
6048..	14	Entire wheat bread	40.11	1.40	8.77	.42	48.79	1.91	2,560
6049..	15	Entire wheat bread	40.39	1.39	8.67	.43	48.62	1.89	2,558
6064..	16	White bread	38.04	1.45	9.07	1.95	49.65	1.29	2,818
6065..	17	White bread	37.43	1.47	9.19	1.87	50.22	1.29	2,840
6077..	18	White bread	37.35	1.44	8.97	2.39	49.93	1.35	2,845
6078..	19	White bread	37.61	1.43	8.96	2.29	49.65	1.49	2,829
6086..	20	Entire wheat bread	38.34	1.51	9.43	2.62	48.21	1.40	2,859
6087..	21	Entire wheat bread	38.83	1.49	9.29	2.68	47.83	1.37	2,829
6097..	22	Graham bread	42.09	1.14	7.15	2.97	46.21	1.58	2,639
6098..	23	Graham bread	41.90	1.19	7.42	2.75	46.46	1.47	2,648
6120..	24	White bread	38.14	1.45	9.04	1.34	50.33	1.15	2,809
6008..	5	Milk	86.87	.49	3.06	3.70	5.60	.77	792
6009..	6	Milk	86.87	.55	3.44	4.00	4.93	.76	799
6010..	7	Milk	86.87	.53	3.31	4.00	5.02	.80	780
6011..	8	Milk	86.52	.53	3.31	4.25	5.16	.76	807
6032..	9-12	Milk	86.45	.55	3.44	4.00	5.38	.73	823
6033..	9-12	Milk	86.07	.53	3.31	3.95	5.93	.74	819
6046..	13-15	Milk	86.39	.55	3.44	4.15	5.30	.72	820

PERCENTAGE COMPOSITION AND HEATS OF COMBUSTION—CONCLUDED.

Laboratory Number.	Number Experiment.	Material.	Water.	Nitrogen.	Protein.	Fat.	Carbohydrates.	Ash.	Heats of combustion. Determined.
			%	%	%	%	%	%	Cal.
6057..	13-15	Milk	86.43	.55	3.44	4.00	5.34	.79	812
6066..	16-17	Milk	87.20	.56	3.50	4.20	4.41	.69	728
6068..	16-17	Milk	86.81	.59	3.69	4.20	4.60	.70	799
6071..	16-17	Milk	86.72	.56	3.50	4.20	4.88	.70	752
6079..	18-19	Milk	86.38	.53	3.31	4.25	5.56	.50	797
6080..	18-19	Milk	86.84	.57	3.56	3.98	5.08	.54	774
6088..	20-21	Milk	85.51	.59	3.69	5.00	5.15	.65	902
6089..	20-21	Milk	86.02	.57	3.56	5.00	4.84	.58	857
6099..	22-23	Milk	86.07	.58	3.63	4.60	4.95	.75	888
6100..	22-23	Milk	86.88	.54	3.38	4.60	4.52	.62	814
6121..	24	Milk	85.55	.58	3.63	5.40	4.67	.75	898
6067..	16-17	Butter	9.93	.21	1.31	85.00	......	3.76	......
6081..	18-19	Butter	11.44	.22	1.38	82.45	......	4.73	.....
6090..	20-21	Butter	13.04	.13	.81	80.19	......	5.96	......
6107..	22-23	Butter	13.26	.18	1.13	79.13	......	6.48	.....
6122..	24	Butter	13.20	.20	1.25	81.48	......	4.07	......

PERCENTAGE COMPOSITION AND HEATS OF COMBUSTION PER GRAM OF DRY MATTER OF FOOD MATERIALS AND FECES IN THE DIGESTION EXPERIMENTS HERE REPORTED.

Laboratory number.	Number experiment.	Material.	Nitrogen.	Protein.	Fat.	Carbohydrates.	Ash.	Heats of combustion. Determined.
			%	%	%	%	%	Cal.
6001..	1	White bread	2.20	13.73	2.70	82.48	1.09	4,444
6002..	2	White bread	2.12	13.25	2.57	83.05	1.13	4,484
6003 .	3	White bread	2.13	13.29	2.92	81.80	1.99	4,480
6004..	4	White bread	2.12	13.24	2.64	82.01	2.11	4,457
6005..	5	White bread	2.07	12.91	4.51	79.57	3.01	4,463
6006..	6	White bread	2.06	12.89	3.34	80.88	2.89	4,441
6007..	7-8	White bread	2.47	15.46	1.31	82.00	1.23	4,389
6034..	9	Graham bread	2.25	14.07	1.79	79.94	4.20	4,221
6035..	10	Graham bread	2.27	14.20	1.81	80.66	3.33	4,263
6036..	11	Graham bread	2.24	14.03	1.85	80.14	3.98	4,253
6037..	12	Graham bread	2.18	13.64	2.01	80.80	3.55	4,264
6047..	13	Entire wheat bread	2.34	14.61	.73	81.47	3.19	4,281
6048..	14	Entire wheat bread	2.34	14.61	.73	81.47	3.19	4,275
6049..	15	Entire wheat bread	2.34	14.61	.73	81.47	3.19	4,266
6064..	16	White bread	2.34	14.64	3.15	80.13	2.08	4,548
6065..	17	White bread	2.35	14.68	2.99	80.26	2.07	4,538
6077..	18	White bread	2.29	14.32	3.82	79.70	2.16	4,541
6078..	19	White bread	2.30	14.36	3.67	79.58	2.39	4,533
6086..	20	Entire wheat bread	2.45	15.30	4.24	78.17	2.28	4,636
6087..	21	Entire wheat bread	2.43	15.19	4.38	78.20	2.24	4,625
6097..	22	Graham bread	1.98	12.35	5.14	79.77	2.74	4,662
6098..	23	Graham bread	2.04	12.77	4.73	79.96	2.54	4,557
6120..	24	White bread	2.34	14.61	2.17	81.36	1.86	4,816
6020..	1	Feces	5.35	33.47	12.86	37.26	16.41	6,074
6021..	2	Feces	8.57	53.67	17.70	18.29	10.34	5,950
6022..	3	Feces	5.96	37.22	14.25	28.32	20.21	5,361
6023..	4	Feces	8.83	55.16	14.69	18.37	11.78	5,900
6024..	5	Feces	6.35	39.69	20.04	25.89	14.38	5,800
6025..	6	Feces	4.82	30.14	17.38	29.97	22.51	5,611
6026..	7	Feces	5.27	32.91	12.51	32.86	21.72	5,563

PERCENTAGE COMPOSITION AND HEATS OF COMBUSTION—CONCLUDED.

Laboratory number.	Number experiment.	Material.	Nitrogen.	Protein.	Fat.	Carbohydrates.	Ash.	Heats of combustion. Determined.
			%	%	%	%	%	Cal.
6027..	8	Feces	5.27	32.93	23.62	22.46	20.99	5,424
6042..	9	Feces	4.11	25.69	7.74	49.15	17.42	5,220
6043..	10	Feces	4.24	26.52	9.95	44.53	19.00	4,613
6044..	11	Feces	3.74	23.40	7.95	48.19	20.46	4,890
6045..	12	Feces	4.07	25.44	8.54	44.56	21.46	4,654
6051..	13	Feces	5.10	31.88	12.86	35.35	19.91	5,400
6052..	14	Feces	4.10	25.64	8.52	39.42	26.42	4,340
6053..	15	Feces	4.47	27.91	10.25	38.18	23.66	4,736
6069..	16	Feces	4.40	27.52	16.87	31.70	23.91	5,753
6070..	17	Feces	4.87	30.45	27.42	25.40	16.73	6,019
6082..	18	Feces	3.94	24.65	12.95	36.17	26.23	5,604
6083..	19	Feces	4.11	25.70	11.91	39.55	22.84	6,082
6091..	20	Feces	4.43	27.68	15.52	38.43	18.37	5,667
6092..	21	Feces	4.71	29.46	14.81	40.71	15.02	5,866
6103..	22	Feces	3.40	21.23	9.14	52.29	17.34	5,035
6104..	23	Feces	3.78	23.63	8.41	52.62	15.34	5,065
6124..	24	Feces	3.01	18.81	12.47	43.71	25.01	5,844

DIGESTION EXPERIMENTS WITH BREAD.

The experiments here reported were made in 1896 and 1897. The subjects were young men with vigorous appetites and apparently normal digestion.

The food eaten.—The experiments began in each case with a supper of milk, with which each subject took six gelatine capsules filled with lamp-black. For the two days following the food consisted chiefly of the bread under investigation. Butter was eaten with the bread, and the men were allowed milk and coffee with sugar. On the morning following the second day of the bread diet, the men again took lamp-black in capsules and a breakfast of milk, no solid food being taken until noon.

No attempt was made to limit the amount of food taken. The food of the men was kept separate. Whenever a new loaf was needed, it was weighed and quartered, one quarter serving for analysis. At the close of the experiment the food remaining was weighed and the amount subtracted from that furnished.

Feces.—The feces were deposited in a line in large tins provided for the purpose. That coming from the milk taken at the beginning and end of the experiment, being deeply colored by the lamp-black, was for the most part readily separated from the feces coming from the bread diet.

Urine.—As no marker can be used for urine, it was collected for the two days of the bread diet, it being understood, of course, that this does not correspond to the food taken during that period.

The tables which follow give the details of the digestion experiments, the table on page 193 containing a summary of the results.

There is nothing in the table which requires explanation unless it is the method of calculating the "per cent of energy utilized." This is the same as used at the Storrs (Conn.) Experiment Station and is described in the report of that Station for 1894,* from which the following is quoted.

"When protein is burned in the calorimeter it is completely oxidized, the carbon being burned to carbon dioxide and the

* Fuel values of digested nutrients in experiments with sheep, W. O. Atwatar and Chas. D. Woods.

hydrogen to water. The nitrogen is left uncombined. When protein is consumed in the body the oxidation is not complete. The nitrogen is left in urea, uric acid and other allied compounds, all of which contain carbon and hydrogen, together with some oxygen. In estimating the actual fuel value of the digested ingredients which an animal can utilize, allowance must be made for these unconsumed residual products, which are excreted by the kidneys. Urea is usually the most abundant of these excretory products, and it is here assumed that all of the nitrogen of the digested protein is excreted as urea. The fuel value of urea as determined by Stohmann and Berthelot is 2.53 Calories per gram.

"The method used in the calculations here has been as follows: Urea (CON_2H_4) contains 46.67 per cent of nitrogen. Hence nitrogen multiplied by the factor 2.143 equals urea. The protein as here estimated is the nitrogen multiplied by 6.25. Hence dividing the protein by 6.25 and multiplying the quotient by 2.143 gives the equivalent urea. Assuming that all of the digested protein is excreted as urea, the number of grams of urea multiplied by 2.53 the fuel value of one gram of urea, gives the total fuel value of the urea equivalent to the digested protein. But (protein divided by 6.25) $\times$ 2.143 $\times$ 2.53 = protein $\times$ .87 This last expression, protein $\times$ .87, therefore, represents the fuel value of the urea equivalent to the digestible protein."

Combustions of urine have shown that the fuel value of the organic matter of urine is higher than that of urea. When sufficient data have accumulated to warrant its adoption, another factor will need to be employed; until then it is probably better to use that for urea. As the total fuel value of the urea and other organic materials found in urine is small in comparison with the fuel value of the food ingested, the error in the assumption here involved is not a large one.

DIGESTION EXPERIMENT No. 1.

Kind of food, white bread.
Subject; H. B. S.
Weight (without clothes); at beginning 145 lbs., at end 147 lbs.
Beef tea, coffee, tea and water were drunk with the bread ad libitum.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6001	White bread	1,633	1,032.7	143.4	28.3	861.0	11.4	4,639
	Total	1,633	1,032.7	143.4	28.3	861.0	11.4	4,639
6020	Feces	....	32.6	13.1	5.0	14.5	6.4	178
	Amount digested	....	1,000.1	130.3	23.3	846.5	5.0	4,461
	Per cent digested	....	96.84	90.87	82.33	98.31	43.86	
	Estimated heat of combustion of urine	....	....	....	....	....	....	113
	Energy of food oxidized in the body ..	....	....	....	....	....	....	4,348
	Per cent energy utilized................	....	....	....	....	....	....	93.7

DIGESTION EXPERIMENT No. 2.

Kind of food; white bread.
Subject; H. B. S. (same as No. 1).
Beef tea, coffee, tea, and water were drunk ad libitum.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6002	White bread..........	956	619.3	83.0	16.0	520.3	7.0	2,809
	Total	956	619.3	83.0	16.0	520.3	7.0	2,809
6021	Feces	....	27.8	16.6	5.5	5.7	3.2	165
	Amount digested	....	591.5	66.4	10.5	514.6	3.8	2,644
	Per cent digested	....	95.51	80.00	65.62	98.90	54.29	
	Estimated heat of combustion of urine	....	....	....	....	....	....	58
	Energy of food oxidized in the body ..	....	....	....	....	....	....	2,586
	Per cent energy utilized	....	....	....	....	....	....	92.4

DIGESTION EXPERIMENT No. 3.

Kind of food; white bread.
Subject; L. H. H.
Beef tea, coffee, tea and water were drunk ad libitum.

Laboratory number of sample.		Weight food material—Grams.	Total organic material—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6003	White bread	1,080.0	691.3	93.8	20.6	576.9	14.1	3,160
	Total	1,080.0	691.3	93.8	20.6	576.9	14.1	3,160
6022	Feces	....	37.5	17.5	6.7	13.3	9.5	213
	Amount digested	....	653.8	76.3	13.9	563.6	4.6	2,947
	Per cent digested	....	94.58	81.68	67.47	97.69	32.62	....
	Estimated heat of combustion of urine	....	....	....	....	....	....	66
	Energy of food oxidized in the body ..	....	....	....	....	....	....	2,881
	Per cent energy utilized	....	....	....	....	....	....	91.2

DIGESTION EXPERIMENT No. 4.

Kind of food; white bread.
Subject; I. W. F.
Beef tea, coffee, tea and water were drunk ad libitum.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6004	White bread..........	1,069	689.5	93.3	18.6	577.6	14.9	3,141
	Total	1,069	689.5	93.3	18.6	577.6	14.9	3,141
6023	Feces	. ...	36.8	23.0	6.1	7.7	4.9	205
	Amount digested.....	....	652.7	70.3	12.5	569.9	10.0	2,936
	Per cent digested	....	94.66	75.35	67.20	98.67	67.11	
	Estimated heat of combustion of urine	....	....	....	....	....	....	61
	Energy of food oxidized in the body...	....	....	....	....	....	....	2,875
	Per cent energy utilized.............	....	....	....	....	....	....	91.5

DIGESTION EXPERIMENT No. 5.

Kind of food; white bread and milk.
Subject; L. H. H.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6005	White bread	1,116.0	713.8	95.0	33.3	585.4	22.1	3,284
6008	Milk	803.3	99.3	24.6	29.7	45.0	6.2	636
6009	Milk	927.0	114.7	31.9	37.1	45.7	7.0	741
	Total	....	927.8	151.5	100.1	676.1	35.3	4,661
6024	Feces	....	44.2	20.5	10.4	13.4	7.5	113
	Amount digested.....	....	883.6	131.0	89.7	662.7	27.8	4,548
	Per cent digested ...	....	95.24	86.47	89.61	98.02	78.75	
	Estimated heat of combustion of urine	....	....	....	....	....	....	114
	Energy of food oxidized in the body ..	....	....	....	....	....	....	4,434
	Per cent energy utilized	....	....	....	....	....	....	95.1

DIGESTION EXPERIMENT No. 6.

Kind of food; white bread and milk.
Subject; H. B. S.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6006	White bread	977.0	632.3	83.9	21.8	526.6	18.9	2,892
6008	Milk	1,390.5	171.8	42.5	51.4	77.9	10.7	1,101
6009	Milk	1,339.0	165.7	46.1	53.6	66.0	10.2	1,070
	Total	.. ....	969.8	172.5	126.8	670.5	39.8	5,063
6025	Feces	....	40.7	15.9	9.1	15.7	11.9	236
	Amount digested	..... .	929.1	156.6	117.7	654.8	27.9	4827
	Per cent digested	... .	95.80	90.78	92.82	97.66	70.10	
	Estimated heat of combustion of urine	....	....	....	....	.. ....	....	136
	Energy of food oxidized in the body ..	... .	....	....	.....	....	... .	4,691
	Per cent energy utilized	....	....	....	....	....	....	92.6

DIGESTION EXPERIMENT No. 7.

Kind of food; white bread and milk.
Subject; C. W. S.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6007	White bread	2,042	1,240.4	193.9	16.5	1,030.0	15.5	5,509
6010	Milk	1,548	190.8	51.2	61.9	77.7	12.4	1,197
6011	Milk	2,064	262.5	68.3	87.7	106.5	15.7	1,666
	Total	....	1,693.7	313.4	166.1	1,214.2	43.6	8,372
6026	Feces	....	60.2	25.3	9.6	25.3	16.7	342
	Amount digested	....	1,633.5	288.1	156.5	1,188.9	26.9	8,030
	Per cent digested	....	96.45	91.93	94.22	97.91	61.69	....
	Estimated heat of combustion of urine	....	....	....	....	....	....	251
	Energy of food oxidized in the body ..	....	....	....	....	....	....	7,779
	Per cent energy utilized	....	....	....	....	....	....	92.9

DIGESTION EXPERIMENT No. 8.

Kind of food; white bread and milk.
Subject; P. F. F.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6007	White bread	1,197.0	726.9	113.7	9.7	603.5	9.1	3,230
6010	Milk	1,826.6	225.3	60.5	73.1	91.7	14.6	1,428
6011	Milk	1,702.8	216.6	56.4	72.4	87.8	12.9	1,374
	Total	....	1,168.8	230.6	155.2	783.0	36.6	6,032
6027	Feces	....	60.1	25.0	18.0	17.1	16.0	375
	Amount digested	.... ..	1,108.7	205.6	137.2	756.9	20.6	5,657
	Per cent digested	....	94.86	89.16	88.40	97.82	56.12	
	Estimated heat of combustion of urine	....	....	... ..	....	....	....	179
	Energy of food oxidized in the body ..	....	....	....	....	....	......	5,478
	Per cent energy utilized	....	....	....	....	.. ..	....	90.8

DIGESTION EXPERIMENT No. 9.

Kind of food; graham bread and milk.
Subject; C. W. S.

Laboratory Number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6034	Graham bread	1,593.0	1,096.3	161.0	20.5	914.8	48.0	4,830
6032	Milk	2,218.8	284.5	76.3	88.8	119.4	16.2	1,826
6033	Milk	2,579.0	340.1	85.4	101.8	152.9	19.1	2,112
	Total...............	....	1,720.9	322.7	211.1	1,187.1	83.3	8,768
6042	Feces	....	126.6	39.4	11.9	75.3	26.7	637
	Amount digested.....	....	1,594.3	283.3	199.2	1,111.8	56.6	8,131
	Per cent digested	....	92.64	87.79	94.36	93.66	67.95	
	Estimated heat of combustion of urine	....	....	....	....	....	....	247
	Energy of food oxidized in the body...	....	....	....	....	....	....	7,884
	Per cent energy utilized :............	....	....	....	....	....	....	89.9

DIGESTION EXPERIMENT No. 10.

Kind of food; graham bread and milk.
Subject; F. H. M.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6035	Graham bread........	1,317.0	739.3	108.5	13.8	617.0	25.6	3,262
6032	Milk.....................	1,341.6	172.0	46.1	53.7	72.2	9.8	1,104
6033	Milk.....................	2,717.0	358.3	89.9	107.3	161.1	20.1	2,225
	Total	....	1,269.6	244.5	174.8	850.3	55.5	6,591
6043	Feces	....	84.7	27.7	10.4	46.6	19.9	440
	Amount digested.....	....	1,184.9	216.8	164.4	803.7	35.6	6,151
	Per cent digested	....	93.33	88.67	94.05	94.52	64.13	
	Estimated heat of combustion of urine	....	....	....	....	....	....	189
	Energy of food oxidized in the body...	....	....	....	....	....	....	5,962
	Per cent energy utilized................	....	....	....	....	....	....	90.6

DIGESTION EXPERIMENT No. 11.

Kind of food; graham bread and milk.
Subject; C. D. H.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6036	Graham bread........	1,361.0	629.7	92.0	12.3	525.4	26.2	2,788
6032	Milk..................	2,734.0	350.5	94.0	109.4	147.1	20.0	2,250
6033	Milk..................	2,889.6	381.1	95.6	114.1	171.4	21.4	2,367
	Total	....	1,361.3	281.6	235.8	843.9	67.6	7,405
6044	Feces	....	77.6	22.8	7.8	47.0	19.9	391
	Amount digested	....	1,283.7	258.8	228.0	796.9	47.7	7,014
	Per cent digested.....	....	94.29	91.90	96.69	94.43	70.56	
	Estimated heat of combustion of urine	....	....	....	....	....	....	225
	Energy of food oxidized in the body...	....	....	....	....	....	....	6,789
	Per cent energy utilized..............	....	....	....	....	....	....	91.7

DIGESTION EXPERIMENT No. 12.

Kind of food; graham bread and milk.
Subject; P. F. F.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6037	Graham bread........	1,326.0	736.9	104.2	15.4	617.3	27.1	3,257
6032	Milk	2,165.2	277.6	74.5	86.6	116.5	15.8	1,782
6033	Milk..................	2,683.0	353.8	88.8	105.9	159.1	19.9	2,199
	Total	....	1,368.3	267.5	207.9	892.9	62.8	7,238
6045	Feces	....	105.6	34.2	11.5	59.9	28.9	541
	Amount digested	....	1,262.7	233.3	196.4	833.0	33.9	6,697
	Per cent digested	....	92.28	87.22	94.47	93.29	53.98	
	Estimated heat of combustion of urine	....	....	....	....	....	....	203
	Energy of food oxidized in the body ..	....	....	....	....	....	....	6,494
	Per cent energy utilized.	....	....	....	....	....	....	89.9

DIGESTION EXPERIMENT No. 13.

Kind of food; entire wheat bread.
Subject; C. W. S.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6047	Entire wheat bread..	1,579	883.3	133.4	6.7	743.2	29.1	3,895
6046	Milk	2,064	266.0	71.0	85.6	109.4	14.9	1,692
6057	Milk	2,274	290.6	78.2	91.0	121.4	18.0	1,847
	Total	....	1,439.9	282.6	183.3	974.0	62.0	7,434
6051	Feces	......	77.4	30.8	12.4	34.2	19.2	424
	Amount digested	....	1,362.5	251.8	170.9	939.8	42.8	7,010
	Per cent digested....	....	94.62	89.10	93.23	96.49	69.03	
	Estimated heat of combustion of urine	....	....	....	....	....	....	219
	Energy of food oxidized in the body ..	....	....	....	....	....	....	6,791
	Per cent energy utilized..............	....	....	....	....	....	....	91.4

DIGESTION EXPERIMENT No. 14.

Kind of food; entire wheat bread.
Subject; P. F. F.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6048	Entire wheat bread..	1,949.0	1,130.0	171.0	8.2	950.8	37.3	4,989
6046	Milk	2,992.8	385.8	103.0	124.2	158.6	21.6	2,454
6057	Milk	2,585.0	330.3	88.9	103.4	138.0	20.4	2,100
	Total	....	1,846.1	362.9	235.8	1247.4	79.3	9,543
6052	Feces	....	55.8	23.3	6.5	26.0	20.0	295
	Amount digested	....	1,790.3	339.6	229.3	1221.4	59.3	9,248
	Per cent digested	....	96.98	93.58	97.24	97.91	74.78	
	Estimated heat of combustion of urine	....	....	....	....	....	....	296
	Energy of food oxidized in the body ..	....	....	....	....	....	....	8,952
	Per cent energy utilized..............	....	....	....	....	....	....	93.8

DIGESTION EXPERIMENT No. 15.

Kind of food; entire wheat bread.
Subject; A. B. O.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6049	Entire wheat bread..	1,600.0	923.8	139.0	6.9	777.9	30.2	4,093
6046	Milk	2,373.6	305.9	81.6	98.5	125.8	17.1	1,946
6057	Milk	2,585.0	330.3	88.9	103.4	138.0	20.4	2,100
	Total	....	1,560.0	309.5	208.8	1,041.7	67.7	8,139
6053	Feces..................	....	60.0	22.5	8.1	29.4	18.6	320
	Amount digested ...	....	1,500.0	287.0	200.7	1,012.3	49.1	7,819
	Per cent digested	....	96.15	92.73	96.12	97.18	72.53	
	Estimated heat of combustion of urine	....	....	....	....	....	....	250
	Energy of food oxidized in the body ..	....	....	....	....	....	....	7,569
	Per cent energy utilized..................	....	....	....	....	....	....	93..0

DIGESTION EXPERIMENT No. 16.

Kind of food; white bread with milk, butter and sugar.
Subject; A. J. P.
Weight (without clothes); at beginning 136.9 lbs., at end 136.3 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6064	White bread...........	1,328.6	806.1	120.5	25.9	659.7	17.1	4,744
6066	Milk	800.0	96.9	28.0	33.6	35.3	5.5	582
6068	Milk	1,800.0	224.8	66.4	75.6	82.8	12.6	1,438
6071	Milk	1,200.0	151.0	42.0	50.4	58.6	8.4	902
6067	Butter	185.0	159.7	2.4	157.3	....	7.0	1,476
	Sugar	53.0	53.0	....	....	53.0	....	211
	Total	....	1,491.5	259.3	342.8	889.4	50.6	9,353
6069	Feces..................	....	26.0	9.4	5.8	10.8	8.1	196
	Amount digested	....	1,465.5	249.9	337.0	878.6	42.5	9,157
	Per cent digested	....	98.26	96.31	98.31	98.79	83.99	
	Estimated heat of combustion of urine	....	....	....	....	....	....	217
	Energy of food oxidized in the body ..	....	....	....	....	....	....	8,940
	Per cent energy utilized	....	....	....	....	....	....	95.6

DIGESTION EXPERIMENT No. 17.

Kind of food; white bread with milk, butter and sugar.
Subject; B. R. M.
Weight (without clothes); at beginning 165.4 lbs., at end 164.2 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6065	White bread	1,642.2	1,006.4	150.9	30.7	824.8	21.2	4,664
6066	Milk..................	800.0	96.9	28.0	33.6	35.3	5.5	582
6068	Milk..................	1,455.0	181.7	53.7	61.1	66.9	10.2	1,163
6071	Milk..................	800.0	100.6	28.0	33.6	39.0	5.6	602
6067	Butter................	259.6	224.0	3.4	220.6	....	9.8	2,070
	Sugar................	148.6	148.6	....	....	148.6	....	592
	Total	....	2,758.2	264.0	379.6	1,114.6	52.3	9,673
6070	Feces.................	....	61.9	22.6	20.4	18.9	12.4	447
	Amount digested.....	....	2,696.3	241.4	359.2	1,095.7	39.9	9,226
	Per cent digested	....	97.75	91.44	94.62	98.34	76.29	
	Estimated heat of combustion of urine	....	....	....	....	....	....	210
	Energy of food oxidized in the body ..	....	....	....	....	....	....	9,016
	Per cent energy utilized...............	....	....	....	....	....	....	93.2

DIGESTION EXPERIMENT No. 18.

Kind of food; white bread with milk, butter and sugar.
Subject; A. J. P.
Weight (without clothes); at beginning 134.5 lbs., at end 134.5 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6077	White bread..........	1,168.6	716.3	104.9	27.9	583.5	15.8	3,325
6079	Milk	2,200.0	288.7	72.8	93.5	122.4	11.0	1,753
6080	Milk..................	1,600.0	202.0	57.0	63.7	81.3	8.6	1,238
6081	Butter................	146.4	122.7	2.0	120.7	....	6.9	1,133
	Sugar.................	59.6	59.6	......	....	59.6	....	238
	Total	....	1,389.3	236.7	305.8	846.8	42.3	7,687
6082	Feces	....	32.5	10.9	5.7	15.9	11.5	247
	Amount digested	....	1,356.8	225.8	300.1	830.9	30.8	7,440
	Per cent digested	....	97.66	95.40	98.12	98.13	72.83	
	Estimated heat of combustion of urine	....	....	......	......	......	......	196
	Energy of food oxidized in the body ..	....	....	....	....	....	....	7,244
	Per cent energy utilized	....	....	......	....	....	....	94.2

DIGESTION EXPERIMENT No. 19.

Kind of food; white bread with milk, butter and sugar.
Subject; O. W. K.
Weight (without clothes); at beginning 135.1 lbs., at end 134 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6078	White bread	1,137.6	692.7	102.0	26.0	564.7	17.0	3,218
6079	Milk	2,200.0	288.7	72.8	93.5	122.4	11.0	1,753
6080	Milk	1,600.0	202.0	57.0	63.7	81.3	8.6	1,238
6081	Butter	135.6	113.7	1.9	111.8	....	6.4	1,040
	Sugar	80.4	80.4	....	....	80.4	......	321
	Total	....	1,377.5	233.7	295.0	848.8	43.0	7,570
6083	Feces	....	32.4	10.8	5.0	16.6	9.6	242
	Amount digested	....	1,345.1	222.9	290.0	832.2	34.4	7,328
	Per cent digested	....	97.65	95.36	98.05	98.30	80.00	
	Estimated heat of combustion of urine	....	....	....	....	....	....	194
	Energy of food oxidized in the body	....	....	....	...	....	....	7,134
	Per cent energy utilized	....	....	....	....	....	....	94.2

DIGESTION EXPERIMENT No. 20.

Kind of food; entire wheat bread with milk, butter and sugar.
Subject; A. J. P.
Weight (without clothes); at beginning 133.5 lbs., at end 134.7 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6086	Entire wheat bread	1,247.6	751.7	117.6	32.7	601.4	17.5	3,567
6088	Milk	1,500.0	207.6	55.4	75.0	77.2	9.8	1,353
6089	Milk	545.0	73.0	19.4	27.2	26.4	3.1	467
6090	Butter	248.8	201.5	2.0	199.5	....	14.8	1,866
	Sugar	109.6	109.6	....	....	109.6	....	437
	Total	....	1,343.4	194.4	334.4	814.6	45.2	7,690
6091	Feces	....	43.3	14.7	8.2	20.4	9.8	301
	Amount digested	....	1,300.1	179.7	326.2	794.2	35.4	7,389
	Per cent digested	....	96.77	90.38	97.54	97.49	78.32	
	Estimated heat of combustion of urine	....	....	....	....	....	....	156
	Energy of food oxidized in the body	....	....	....	....	....	....	7,233
	Per cent energy utilized	....	....	....	....	....	....	95.3

DIGESTION EXPERIMENT No. 21.

Kind of food; entire wheat bread, with milk, butter and sugar.
Subject; O. W. K.
Weight (without clothes); at beginning 135.5 lbs; at end 135.1 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6087	Entire wheat bread..	1,210 4	723.9	112.5	32.5	578.9	16.6	3,424
6088	Milk	1,500.0	207.6	55.4	75.0	77.2	9.8	1,353
6089	Milk..	545.0	73.0	19.4	27.2	26.4	3.1	467
6090	Butter..................	267.6	216.8	2.2	214.6	....	15.9	2,008
	Sugar....................	184.8	184.8	....	....	184.8	....	737
	Total	....	1,406.1	189.5	349.3	867.3	45.4	7,989
6092	Feces..................	....	36.6	12.4	7.0	17.2	8.2	275
	Amount digested.....	....	1,369.5	177.1	342.3	850.1	37.2	7,714
	Per cent digested	....	97.39	93.46	98.00	98.02	81.91	
	Estimated heat of combustion of urine	....	....	....	....	....	....	154
	Energy of food oxidized in the body ..	....	....	....	....	....	....	7,560
	Per cent energy utilized	....	.. ..	....	....	....	....	94.7

DIGESTION EXPERIMENT No. 22.

Kind of food; graham bread, with milk, butter and sugar.
Subject; A. J. P.
Weight (without clothes), at beginning 136.1 lbs., at end 135.7 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6097	Graham bread	1,584.1	892.4	113.3	47.1	732.0	25.0	4,180
6099	Milk......................	1,200.0	158.2	43.6	55.2	59.4	9.0	1,065
6100	Milk	1,000.0	125.0	33.8	46.0	45.2	6.2	814
6107	Butter..................	189.8	152.4	2.1	150.3	....	12.3	1,410
	Sugar....................	102.0	102.0	... .	....	102.0	....	407
	Total	... ..	1,430.0	192.8	298.6	938.6	52.5	7,876
6103	Feces..................	....	91.5	23.5	10.1	57.9	19.3	558
	Amount digested	....	1,338.5	169.3	288.5	880.7	33.2	7,318
	Per cent digested	....	93.60	87.81	96.62	93.83	63.24	
	Estimated heat of combustion of urine	....	....	....	... .	....	....	147
	Energy of food oxidized in the body ..	....	... .	....	....	....	....	7,171
	Per cent energy utilized..................	......	. ...	....	....	....	....	91.0

DIGESTION EXPERIMENT NO. 23.

Kind of food; graham bread, with milk, butter and sugar.
Subject; O. W. K.
Weight (without clothes); at beginning, 136.2 lbs., at end, 136 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6098	Graham bread	1,200.0	679.8	89.1	33 0	557.7	17.6	3,178
6099	Milk	1,400.0	184.5	50.8	64.4	69.3	10.5	1,243
6100	Milk	1,076.0	134.5	36.4	49.5	48.6	6.7	876
6107	Butter	201.4	161.7	2.3	159.4	....	13.0	1,495
	Sugar	185.0	185.0	....	....	185.0	....	738
	Total	....	1,345.5	178.6	306.3	860.6	47.8	7,530
6104	Feces	....	78.8	22.0	7.8	49.0	14.3	472
	Amount digested	....	1,266.7	156.6	298.5	811.6	33.5	7,058
	Per cent digested	....	94.14	87.68	97.45	94.31	70.08	
	Estimated heat of combustion of urine	....	....	....	....	....	....	155
	Energy of food oxidized in the body	....	....	....	....	....	....	6,903
	Per cent energy utilized	....	....	....	....	....	....	91.7

DIGESTION EXPERIMENT NO. 24.

Kind of food; white bread, with milk, butter and sugar.
Subject; O. W. K.
Weight (without clothes); at beginning 147.6 lbs., at end, 144 7 lbs.

Laboratory number of sample.		Weight food material—Grams.	Total organic matter—Grams.	Protein—Grams.	Fat—Grams.	Carbo-hydrates—Grams.	Ash—Grams.	Heats of combustion, determined—Calories.
6120	White bread	568.0	344.8	51.3	7 6	285.9	6.5	1,595
6121	Milk	1,629.6	223.3	59.2	88.0	76.1	12.2	1,463
6122	Butter	67.8	56.0	.8	55.2	......	2.8	516
	Sugar	40.2	40.2	....	....	40.2	....	125
	Total	....	664.3	111.3	150.8	402.2	21.5	3,699
6124	Feces	....	9.3	2.4	1.5	5.4	3.1	50
	Amount digested	....	655.0	108.9	149.3	396.8	18.4	3,649
	Per cent digested	....	98.60	97.84	99.00	98.66	85.58	
	Estimated heat of combustion of urine	....	....	....	....	....	....	95
	Energy of food oxidized in the body	....	....	....	....	....	....	3,554
	Per cent energy utilized	....	....	....	....	....	....	96.1

SUMMARY OF DIGESTION EXPERIMENTS.

AVAILABILITY OF NUTRIENTS AND HEATS OF COMBUSTION.

Number of experiment.	Kinds of Food.	Subject.	Total organic matter.	Protein.	Fat.	Carbohydrates.	Ash.	Heats of combustion, determined.
			%	%	%	%	%	%
1	White bread	H. B. S.	96.8	90.9	82.3	98.3	43.9	93.7
2	White bread	H. B. S.	95.5	80.0	65.6	98.9	54.3	92.4
3	White bread	L. H. H.	94.6	81.7	67.5	97.7	32.6	91.2
4	White bread	I. W. F.	94.7	75.4	67.2	98.7	67.1	91.5
	White bread, average	4	95.4	82.0	70.7	98.4	49.5	92.2
5	White bread and milk	L. H. H.	95.2	86.5	89.6	98.0	78.8	95.1
6	White bread and milk	H. B. S.	95.8	90.8	92.8	97.7	70.1	92.6
7	White bread and milk	C. W. S.	96.5	91.9	94.2	97.9	61.7	92.9
8	White bread and milk	P. F. F.	94.9	89.2	88.4	97.8	56.1	90.8
16	White bread and milk	A. J. P.	98.3	96.3	98.3	98.8	84.0	95.6
17	White bread and milk	B. R. M.	97.8	91.4	94.6	98.3	76.3	93.2
18	White bread and milk	A. J. P.	97.7	95.4	98.1	98.1	72.8	94.2
19	White bread and milk	O. W. K.	97.7	95.4	98.3	98.1	80.0	94.2
24	White bread and milk	O. W. K.	98.6	97.8	99.0	98.7	85.6	96.1
	White bread and milk, average.	9	96.9	92.8	94.8	98.2	73.9	93.9
9	Graham bread and milk	C. W. S.	92.6	87.8	94.4	93.7	68.0	89.9
10	Graham bread and milk	F. H. M.	93.3	88.7	94.1	94.5	64.1	90.6
11	Graham bread and milk	C. D. H.	94.3	91.9	96.7	94.4	70.6	91.7
12	Graham bread and milk	P. F. F.	92.3	87.2	94.5	93.3	54.0	89.9
22	Graham bread and milk	A. J. P.	93.6	87.8	96.6	93.8	63.2	91.0
23	Graham bread and milk	O. W. K.	94.1	87.7	97.5	94.3	70.1	91.7
	Graham bread and milk, average	6	93.4	88.5	95.6	94.0	65 0	90.8
13	Entire wheat bread and milk	C. W. S.	94.6	89.1	93.2	96.5	69.0	91.4
14	Entire wheat bread and milk	P. F. F.	97.0	93.6	97.2	97.9	74.8	93.8
15	Entire wheat bread and milk	A. B. O.	96.2	92.7	96.1	97.2	72.5	93.0
20	Entire wheat bread and milk	A. J. P.	96.8	90.4	97.5	97.5	78.3	95.3
21	Entire wheat bread and milk	O. W. K.	97.4	93.5	98.0	98.0	81.9	94.7
	Entire wheat bread and milk av.	5	96.4	91.9	96.4	97.4	75.3	93.6

THE INCOME AND OUTGO OF NITROGEN IN THESE EXPERIMENTS.

As previously stated, the urine was collected for each experiment beginning with the morning of the first day and ending with the evening of the third day. The amount passed on rising (about 7 A. M.) in the morning of the first day was not kept and that of the morning of the third day was included with the amount collected.

The weights of the urine, the percentage of nitrogen, weight of nitrogen, heats of combustion per gram, and total heats of combustion are given below. The balance of the income and outgo of nitrogen are given on the opposite page.

WEIGHT OF NITROGEN IN THE URINE FOR EACH EXPERIMENT—TWO DAYS.

Number experiment.	Laboratory number.	Weight of urine.	Per cent nitrogen.	Weight of nitrogen.	Heats of combustion, determined.	
					Per gram.	Total.
		Grams.		Grams.		
1	6012	2,142	1.81	38.77		
2	6013	1,550	1.20	18.60		
3	6014	1,545	1.30	20.08		
4	6015	1,509	1.53	23.09		
5	6016	1,443	1.84	26.55		
6	6017	2,279	1.23	28.03		
7	6018	2,505	1.68	42.08		
8	6019	2,550	1.39	35.44		
9	6038	1,408	1.22	17.18		
10	6039	3,488	1.29	45.00		
11	6040	2,433	0.87	21.17		
12	6041	2,745	1.00	27.45		
13	6054	2,334	1.33	31.04		
14	6055	2,046	1.38	28.23		
15	6056	3,450	1.14	39.33		
16	6072	2,749	1.42	39.04	89	244.7
17	6073	2,208	1.69	37.31	127	280.4
18	6084	2,322	1.54	35.76	114	264.7
19	6085	2,530	1.25	31.62	87	220.1
20	6093	2,042	1.40	28.59	107	218.5
21	6094	2,086	1.46	30.46	119	248.2
22	6105	2,723	1.10	29.95	76	206.9
23	6106	2,259	1.22	27.56	82	185.2
24	6125	1,529	1.58	24.16	131	200.3

BALANCE OF INCOME AND OUTGO OF NITROGEN—TWO DAYS.

Number.	INCOME.	OUTGO.				
	Nitrogen in food.	Nitrogen in feces.	Nitrogen in urine.	Total.	Nitrogen, gain+ loss—.	Protein, gain+ loss—.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1	22.9	2.1	38.8	40.9	—18.0	—112.5
2	13.3	2 7	18.6	21.3	—8.0	—50.0
3	15.0	3.3	20.1	23.4	—8.4	—52.5
4	14.9	3.7	23.1	26.8	—11.9	—74.4
5	24.2	3.3	26.6	29.9	—5.7	—35.6
6	27.6	2.5	28.0	30.5	—2.9	—18.3
7	50.1	4.0	42.1	46.1	+4.0	+25.0
8	36.9	4.0	35.4	39.4	—2.5	—15.6
9	51.6	6.3	17.2	23.5	+28.1	+175.6
10	39.1	4.4	45.0	49.4	—10.3	—64.4
11	45.0	3.7	21.2	24.9	+20.1	+125.6
12	42.8	5.5	27.5	33.0	+9.8	+61.2
13	45.2	4.9	31.0	35.9	+9.3	+58.1
14	58.1	3.7	28.2	31.9	+16.2	+101.3
15	49.5	3.6	39.3	42.9	+6.6	+41.2
16	41.5	1.5	39 0	40.5	+1.0	+6.2
17	42.2	3.6	37.3	40.9	+1.3	+8.1
18	37.9	1.7	35.8	37.5	+0.4	+2.5
19	37.4	1.7	31.6	33.3	+4.1	+25.6
20	31.1	2.4	28.6	31.0	+0.1	+0.6
21	30.3	2.2	30.5	32.7	—2.4	—15.0
22	30.8	3.8	30.0	33.8	—3.0	—18.7
23	28.6	3.5	27.6	31.1	—2.5	—15.6
24	17.8	.4	24.2	24.6	—6.8	—42.5

THE DIGESTIBILITY OF BREAD.

CHAS. D. WOODS and L. H. MERRILL.

The experiments here reported were undertaken for the purpose of ascertaining the comparative digestibility of breads from ordinary bread flour, graham flour and so-called entire wheat flour. Preliminary experiments made by one of us in 1894 had shown that, for (See digestion experiments 1 to 5 and 9 pp. 168 to 170, Report Storrs [Conn.] Experiment Station for 1896) the subject there used, neither bread nor milk when eaten separately were as completely digested as when bread and milk were eaten together. The experiments here reported show that bread and milk are more completely digested than bread alone, (compare experiments 1 to 4 and 5 to 8, 16 to 19 in table on p. 193). In the comparative experiments here reported, the breads were not eaten alone, but were taken with milk, butter and sugar. To reduce the results obtained in this mixed diet to the breads alone necessitated the use of more or less arbitrary factors for the food materials eaten with the bread.

After a careful study of the results of digestion experiments made in this country and Germany, the following factors (percentages of availability) were assumed in calculating the results here reported to bread alone.

	Protein. %	Fats. %	Carbo-hydrates. %
Milk	98	99	98
Butter	--	99	--
Sugar	--	--	98

The application of these factors to other experiments, as well as these here reported upon, seemed to give results that indicate that these are the approximate percentages of availability for the nutrients of these food materials. These applications to the figures obtained in the digestion experiments reported on pages

183-192 will be readily understood, and are given in the following tables. The table on page 207 contains a summary of the results:

DIGESTION EXPERIMENT No. 5.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6008	Milk, not digested	.49	.30	.90	9
6009	Milk, not digested	.64	.37	.91	11
	Feces from the above	1.13	.67	1.81	20
6024	Feces, total	20.50	10.40	13.40	113
	Feces from white bread	19.37	9.73	11.59	93
	Nutrients in white bread	95.00	33.30	585.40	3,284
	Amount of nutrients digested	75.63	23.57	573.81	3,191
	Per cent of nutrients digested	79.61	70.78	98.02	96.95

DIGESTION EXPERIMENT No. 6.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory Number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6008	Milk, not digested	.85	.51	1.56	16
6009	Milk, not digested	.92	.54	1.32	15
	Feces from the above	1.77	1.05	2.88	31
6025	Feces, total	15.90	9.10	15.70	236
	Feces from white bread	14.13	8.05	12.82	205
	Nutrients in white bread	83.90	21.80	526.60	2,892
	Amount of nutrients digested	69.77	13.75	513.78	2,687
	Per cent of nutrients digested	83.16	63.07	97.56	92.90

DIGESTION EXPERIMENT No. 7.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6010	Milk, not digested	1.02	.62	1.55	18
6011	Milk, not digested	1.37	.88	2.13	24
	Feces from the above	2.39	1.50	3.68	42
6026	Feces, total	25.30	9.60	25.30	342
	Feces from white bread	22.91	8.10	21.62	300
	Nutrients in white bread	193.90	16.50	1,030.00	5,509
	Amount of nutrients digested	170.99	8.40	1,008.38	5,209
	Per cent of nutrients digested	88.18	50.91	97.90	94.55

DIGESTION EXPERIMENT No. 8.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory Number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6010	Milk, not digested	1.21	.73	1.83	21
6011	Milk, not digested	1.13	.72	1.76	20
	Feces from the above	2.34	1.45	3.59	41
6027	Feces, total	25.00	18.00	17.10	375
	Feces from white bread	22.66	16.55	13.51	334
	Nutrients in white bread	113.70	9.70	603.50	3,230
	Amount of nutrients digested	91.04	....	589.99	2,896
	Per cent of nutrients digested	80.07	....	97.76	89.67

DIGESTION EXPERIMENT No. 9.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6032	Milk, not digested	1.53	.89	2.39	26
		1.71	1.02	3.06	32
	Feces from the above	3.24	1.91	5.45	58
6042	Feces, total	39.40	11.90	75.30	637
	Feces from graham bread	36.16	9.99	69.85	579
	Nutrients in graham bread	161.00	20.50	914.80	4,830
	Amount of nutrients digested	124.84	10.51	844.95	4,251
	Per cent of nutrients digested	77.54	51.27	92.36	86.02

DIGESTION EXPERIMENT No. 10.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6032	Milk, not digested	.92	.54	1.44	16
6033	Milk, not digested	1.80	1.07	3.22	33
	Feces from the above	2.72	1.61	4.66	49
6043	Feces, total	27.70	10.40	46.60	440
	Feces from graham bread	24.98	8.79	41.94	391
	Nutrients in graham bread	108.50	13.80	617.00	3,262
	Amount of nutrients digested	83.52	5.01	575.06	2,871
	Per cent of nutrients digested	76.98	36.30	93.19	93.67

DIGESTION EXPERIMENT No. 11.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6032	Milk, not digested	1.88	1.09	2.94	33
6033	Milk, not digested	1.91	1.14	3.43	35
	Feces from the above	3.79	2.23	6.37	68
6044	Feces, total	22.80	7.80	47.00	391
	Feces from graham bread	19.01	5.57	40.63	323
	Nutrients in graham bread	92.00	12.30	525.40	2,788
	Amount of nutrients digested	72.99	6.73	484.77	2,465
	Per cent of nutrients digested	79.34	54.72	92.27	88.40

DIGESTION EXPERIMENT No. 12.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6032	Milk, not digested	1.49	.87	2.33	26
6033	Milk, not digested	1.78	1.06	3.18	33
	Feces from the above	3.27	1.93	5.51	59
6045	Feces, total	34.20	11.50	59.90	541
	Feces from graham bread	30.93	9.57	54.39	482
	Nutrients in graham bread	104.20	15.40	617.30	3,257
	Amount of nutrients digested	73.27	5.83	562.91	2,775
	Per cent of nutrients digested	70.32	37.86	91.19	85.22

DIGESTION EXPERIMENT No. 13.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM ENTIRE WHEAT BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6046	Milk, not digested	1.42	.86	2.19	25
6057	Milk, not digested	1.56	.91	2.43	27
	Feces from the above	2.98	1.77	4.62	52
6051	Feces, total	30 80	12.40	34.20	424
	Feces from entire wheat bread	27.82	10.63	29.58	372
	Nutrients in entire wheat bread	133.40	6.70	743.20	3,895
	Amount of nutrients digested	105.58	....	713.62	3,523
	Per cent of nutrients digested	79.15	....	96.02	90.44

DIGESTION EXPERIMENT No. 14.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM ENTIRE WHEAT BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6046	Milk, not digested	2.06	1.24	3.17	36
6057	Milk, not digested	1.78	1.03	2.76	31
	Feces from the above	3.84	2.27	5.93	67
6052	Feces, total	23.30	6.50	26.00	295
	Feces from entire wheat bread	19.46	4.23	20.07	228
	Nutrients in entire wheat bread	171.00	8.20	950.80	4,989
	Amount of nutrients digested	151.54	3.97	930.73	4,761
	Per cent of nutrients digested	88.60	48.41	97.89	95.45

DIGESTION EXPERIMENT No. 15.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM ENTIRE WHEAT BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6046	Milk, not digested	1.63	.99	2.52	28
6057	Milk, not digested	1.78	1.03	2.76	31
	Feces from the above	3.41	2.02	5.28	59
6053	Feces, total	22.50	8.10	29.40	320
	Feces from entire wheat bread	19.09	6.08	24.12	261
	Nutrients in entire wheat bread	139.00	6.90	777.90	4,093
	Amount of nutrients digested	119.91	.82	753.78	3,832
	Per cent of nutrients digested	86.27	10.43	96.90	93.62

DIGESTION EXPERIMENT No. 16.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6066	Milk, not digested	.56	.34	.71	9
6068	Milk, not digested	1.33	.76	1.66	21
6071	Milk, not digested	.84	.50	1.17	14
6067	Butter, not digested	.05	1.57	....	15
	Sugar, not digested	....	....	1.06	4
	Feces from the above	2.78	3.17	4.60	63
6069	Feces, total	9.40	5.80	10.80	196
	Feces from white bread	6.62	2.63	6.20	133
	Nutrients in white bread	120.50	25.90	659.70	4,744
	Amount of nutrients digested	113.88	23.27	653.50	4,611
	Per cent of nutrients digested	94.51	89.85	99.06	97.18

DIGESTION EXPERIMENT No. 17.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6066	Milk, not digested	.56	.34	.71	9
6068	Milk, not digested	1.07	.61	1.34	17
6071	Milk, not digested	.56	.34	.78	9
6067	Butter, not digested	.07	2.21	....	21
	Sugar, not digested	....	....	2.97	12
	Feces from the above	3.26	3.50	5.80	68
6070	Feces, total	22.60	20.40	18.90	447
	Feces from white bread	19.34	16.90	13.10	379
	Nutrients in white bread	150.90	30.70	824.80	4,664
	Amount of nutrients digested	131.56	13.80	811.70	4,285
	Per cent of nutrients digested	87.18	44.95	98.41	91.86

DIGESTION EXPERIMENT No. 18.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6079	Milk, not digested	1.56	.94	2.45	27
6080	Milk, not digested	1.14	.64	1.63	19
6081	Butter, not digested	.04	1.21	....	11
	Sugar, not digested	....	....	1.19	5
	Feces from the above	2.74	2.79	5.27	62
6082	Feces, total	10.90	5.70	15.90	247
	Feces from white bread	8.16	2.91	10.63	185
	Nutrients in white bread	104.90	27.90	583.50	3,325
	Amount of nutrients digested	96.74	24.99	572.87	3,140
	Per cent of nutrients digested	92.22	89.57	98.18	93.17

DIGESTION EXPERIMENT No. 19.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6079	Milk, not digested	1.56	.94	2.45	27
6080	Milk, not digested	1.14	.64	1.63	19
6081	Butter, not digested	.04	1.12	....	11
	Sugar, not digested	....	....	1.61	7
	Feces from the above	2.74	2.70	5.69	64
6083	Feces, total	10.80	5.00	16.60	242
	Feces from white bread	8.06	2.30	10.91	178
	Nutrients in white bread	102.00	26.00	564.70	3,218
	Amount of nutrients digested	93.94	23.70	553.79	3,040
	Per cent of nutrients digested	92.10	91.15	98.07	97.85

DIGESTION EXPERIMENT No. 20.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM ENTIRE WHEAT BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories
6088	Milk, not digested	1.11	.75	1.54	19
6089	Milk, not digested	.39	.27	.53	7
6090	Butter, not digested	.04	1.96	....	18
	Sugar, not digested	....	....	2.19	8
	Feces from the above	1.54	2.98	4.26	52
6091	Feces, total	14.70	8.20	20.40	301
	Feces from entire wheat bread	13.16	5.22	16.14	249
	Nutrients in entire bread	117.60	32.70	601.40	3,567
	Amount of nutrients digested	104.44	27.48	585.26	3,318
	Per cent of nutrients digested	88.81	84.04	97.31	96.85

DIGESTION EXPERIMENT No. 21.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM ENTIRE WHEAT BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6088	Milk, not digested	1.11	.75	1.54	19
6089	Milk, not digested	.39	.27	.53	7
6090	Butter, not digested	.04	2.15	....	20
	Sugar, not digested	....	....	3.70	15
	Feces from the above	1.54	3.17	5.77	61
6092	Feces, total	12.40	7.00	17.20	275
	Feces from entire wheat bread	10.86	3.83	11.43	214
	Nutrients in entire wheat bread	112.50	32.50	578.90	3,424
	Amount of nutrients digested	101.64	28.67	567.47	3,210
	Per cent of nutrients digested	90.35	88.22	98.03	93.77

DIGESTION EXPERIMENT No. 22.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6099	Milk, not digested	.87	.55	1.19	15
6100	Milk, not digested	.68	.46	.90	12
6107	Butter, not digested	.04	1.50	....	14
	Sugar, not digested	....	....	2.04	8
	Feces from the above	1.59	2.51	4.13	49
6103	Feces, total	23.50	10.10	57.90	558
	Feces from graham bread	21.91	7.59	53.77	509
	Nutrients in graham bread	113.30	47.10	732.00	4,180
	Amount of nutrients digested	91.39	39.51	678.23	3,671
	Per cent of nutrients digested	80.66	83.89	92.65	87.82

DIGESTION EXPERIMENT No. 23.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM GRAHAM BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6099	Milk, not digested	1.02	.64	1.39	17
6100	Milk, not digested	.73	.50	.97	13
6107	Butter, not digested	.05	1.59	....	15
	Sugar, not digested	....	....	3.70	15
	Feces from the above	1.80	2.73	6.06	60
6104	Feces, total	22.00	7.80	49.00	472
	Feces from graham bread	20.20	5.07	42.94	412
	Nutrients in graham bread	89.10	33.00	557.70	3,178
	Amount of nutrients digested	68.90	27.93	515.76	2,766
	Per cent of nutrients digested	77.33	84.64	92.48	87.02

DIGESTION EXPERIMENT No. 24.

NUTRIENTS DIGESTED AND ENERGY UTILIZED FROM WHITE BREAD.

Laboratory number.		Protein.	Fat.	Carbo-hydrates.	Heats of combustion, determined.
		Grams.	Grams.	Grams.	Calories.
6121	Milk, not digested	1.18	.88	1.52	21
6122	Butter, not digested	.02	.55	....	5
	Sugar, not digested	....	....	.80	3
	Feces from the above	1.20	1.43	2.32	29
6124	Feces, total	2.40	1.50	5.40	50
	Feces from white bread	1.20	.07	3.08	21
	Nutrients in white bread	51.30	7.60	285.90	1,515
	Amount of nutrients digested	50.10	7.53	282.82	1,574
	Per cent of nutrients digested	97.66	99.08	98.93	98.67

COMPARISON OF NUTRIENTS DIGESTED AND ENERGY UTILIZED IN BREADS MADE FROM ORDINARY BREAD FLOUR, GRAHAM FLOUR, AND ENTIRE WHEAT FLOUR.

THE RESULTS OF THE EXPERIMENTS WITH BREAD AND MILK CALCULATED TO BREAD ALONE.

Number of experiments.	Kinds of Food.	Subject.	Protein.	Fat.	Carbo-hydrates.	Heats of combustion.
			%	%	%	%
1	White bread alone	H. B. S.	90.9	82.3	98.3	93.7
2	White bread alone	H. B. S.	80.0	65.6	98.9	92.4
3	White bread alone	L. H. H	81.7	67.5	97.7	91.2
4	White bread alone	I. W. F.	75.4	67.2	98.7	91.5
	Average of four experiments	....	82.0	70.7	98.4	92.2
5	White bread and milk	L. H. H	79.6	70.8	98.0	97.0
6	White bread and milk	H. B. S	83.2	63.1	97.6	92.9
7	White bread and milk	C. W. S	88.2	50.9	97.9	94.6
8	White bread and milk	P. F. F.	80.1	....	97.8	89.7
16	White bread and milk	A. J. P.	94.5	90.0	99.1	97.2
17	White bread and milk	B. R. M	87.2	45.0	98.4	92.0
18	White bread and milk	A. J. P.	92.2	89.6	98.2	93.2
19	White bread and milk	O. W. K	92.1	91.2	98.1	97.9
24	White bread and milk	O. W. K	97.7	99.1	98.9	98.7
	Average of nine experiments	....	88.3	66.6	98.2	94.8
9	Graham bread and milk	C. W. S	77.5	51.3	92.4	86.0
10	Graham bread and milk	F. H. M	77.0	36.3	93.2	93.7
11	Graham bread and milk	C. D. H	79.3	54.7	92.3	88.4
12	Graham bread and milk	P. F. F	70.3	37.9	91.2	85.2
22	Graham bread and milk	A. J. P.	80.7	83.9	92.7	87.8
23	Graham bread and milk	O. W. K.	77.3	84.6	92.5	87.0
	Average of six experiments	....	77.0	58.1	92.4	88.0
13	Entire wheat bread and milk	C. W. S	79.2	....	96.0	90.4
14	Entire wheat bread and milk	P. F. F	88.6	48.4	97.9	95.5
15	Entire wheat bread and milk	A. B. O.	86.2	10.4	96.9	93.6
20	Entire wheat bread and milk	A. J. P.	88.8	84.0	97.3	96.9
21	Entire wheat bread and milk	O. W. K	90.4	88.2	98.0	93.8
	Average of five experiments	....	86.6	46.2	97.2	94.0

THE ACQUISITION OF ATMOSPHERIC NITROGEN. SOIL INOCULATION.

W. M. Munson.

The remarkable results obtained at the Alabama Experiment Station* from the inoculation of sterile soils with tubercles from various leguminous species, and with nitragin, were referred to by the writer in the last report of this Station.† With the purpose of verifying this work and of comparing several of the "nitragin" cultures with each other and with tubercles from various species of legumes, a series of inoculation experiments was undertaken in the greenhouse during the past season.

For all the work a sterile, sandy subsoil was used. This soil was sterilized once by being placed in a tight box in which was a coil of perforated steam pipe. Steam, at 10 pounds pressure, was passed through the coil for one hour, thus maintaining a temperature of about 200 degrees F. Just before use the soil was again sterilized, for one to one and one-half hours, on three successive days. On these occasions the steam was at 80 pounds pressure. The pots used were all sterilized by steaming for one hour on three successive days and the house was thoroughly sprayed with corrosive sublimate before the pots were put in place. Throughout the test, the water given to the plants was boiled for one to one and one-half hours, on three successive days, before use. Each six-inch pot was given 6.2 grams of complete fertilizer which was first carefully sterilized.

The seed was in all cases soaked for one and one-half hours in corrosive sublimate (1 gram to 1 quart water), placed in a sterilized germinator‡ and moistened with sterilized water.

* Bull. 87 Alabama Experiment Station, 466.

† Rep. Maine Experiment Station, 1897, 130.

‡ The germinator consisted of folds of asbestos cloth which were passed through a flame and then placed in a "Geneva tester" which had been similarly treated.

The plants used in the work included red clover, pea, bean, vetch, and soja bean. The results obtained with each are detailed below:

RED CLOVER.

The seeds were treated as above described. After four days, when the sprouts were ¼ to ⅜ inch long, those which were to be grown with nitragin were immersed in a diluted culture of the species desired (1 c. c. nitragin to 20 c. c. distilled water), after which they were planted ¼-inch deep in the sterilized soil, in 6-inch pots. In the soil inoculated with tubercles, instead of nitragin, the tubercles were placed, two or three together, ½-inch deep by each seed. Eight seeds were planted in each pot, and when the plants were well started they were thinned to five in each. The pots were placed on a bench in the greenhouse and a night temperature of 50° was maintained.

In this trial 3 pots were planted without treatment, 3 were given clover nitragin as above; 3 pea nitragin; 3 lupine nitragin; 3 tubercles of *Swainsona galegifolia* and 3 tubercles of horse bean (*Vicia Faba*).

At this writing the plants present no marked differences.

PEA.

Preliminary treatment of soil and seed as for clover. The plants were thinned to four in each pot when about three inches high. The crop was harvested when in full bloom, as the plants were all attacked with mildew and were losing their foliage.

The results are given in tabular form on the following page.

THE GROWTH OF PEAS ON INOCULATED SOIL.

Treatment.	Highest plant —Feet.	Lowest plant —Feet.	Average height —Feet.	General average —Feet.	Total weight —Grams.	Remarks:
Check.						
Pot No. 1	6.0	5.2	5.6			Well developed tubercles were found in all of the pots.
Pot No. 2	6.2	5.2	5.7	5.6	238	
Pot No. 3	6.0	4.9	5.5			
Pea nitragin.						
Pot No. 1	6.0	5.9	5.9			Tubercles rather more numerous than in the check.
Pot No. 2	6.1	4.4	5.0	5.5	238	
Pot No. 3	6.1	4.7	5.5			
Lupine nitragin.						
Pot No. 1	6.3	5.7	6.0			Tubercles well developed, mostly near surface of pots and near where seed was planted.
Pot No. 2	6.3	5.0	5.6	5.7	301	
Pot No. 3	6.1	4.8	5.6			
Clover nitragin.						
Pot No. 1	6.3	6.0	6.2			As in the preceding and more abundant.
Pot No. 2	6.8	4.8	5.8	5.9	273	
Pot No. 3	6.5	4.2	5.6			
Swainsona tubercles.						
Pot No. 1	5.8	4.5	5.1			Root growth less vigorous than in any of the preceding. Tubercles few and small.
Pot No. 2	6.2	4.8	5.3	5.0	266	
Pot No. 3	5.2	4.3	4.7			
Horse bean tubercles.						
Pot No. 1	5.8	4.0	4.7			General condition as in the last.
Pot No. 2	5.5	4.1	4.7	4.8	210	
Pot No. 3	5.8	4.2	4.9			

The highest plants and the heaviest crop were attained from the seeds treated with lupine nitragin. Pea nitragin had no appreciable effect. The pots given tubercles of swainsona and of horse bean, were both inferior to those receiving no germs; but in the pots receiving no germs, tubercles were found, so that there must have been some source of infection,—possibly the drip from the roof.

In general, the differences with the different cultures were so slight as to be unappreciable, and were not greater than those found in the different pots receiving no germs.

VETCH.

Treated in every way as were peas and clover. When just beginning to bloom, the plants were harvested. The results were, in every way, comparable to those from the pea, detailed above. In no case were there sufficient differences to indicate even a possible advantage from the use of the germ culture.

BEAN.

The remarks concerning the vetch will apply with equal force to the bean. With the bean, however, there was no evidence of tubercles in any of the pots. It should be said that the beans were kept in the same house with the other plants, and it is possible the unfavorable temperature may have affected the results.

A duplicate lot, started a month later, was allowed to come to maturity before harvesting. The plants were yellow and showed lack of vigor, because of low temperature. There was, however, no appreciable difference in the size or appearance of the various lots. It is worthy of note that the plants in one pot inoculated with horse bean tubercles produced small spherical tubercles, about the size of a sweet pea seed. Every plant, in soil inoculated with swainsona, produced tubercles, and those in two of the pots given lupine nitragin. Plants from soil inoculated with clover nitragin, pea nitragin, and from the uninoculated soil produced no tubercles.

SOJA BEAN.

The soja bean plants were small and weak in every instance and in no case were tubercles found except upon one plant from soil inoculated with soja bean tubercles. (The tubercles used were from last year's crop and were so dry it was feared they would be of little value.) There was no noticeable difference in the size and vigor of any of the plants.

GENERAL CONCLUSION.

The experiments thus far carried on at this Station do not justify the recommendation of germ cultures for leguminous crops. In no case did the culture of the specific germ of any given species give better results than did a culture of a nearly related type, and in most cases plants from untreated pots were equally as vigorous and as heavy as were those from inoculated soil.

SKIMMED MILK VS. WATER IN BREAD MAKING.

CHAS. D. WOODS and L. H. MERRILL.

At the dairy meeting of the Board of Agriculture in 1897 one of us presented a paper* in which emphasis was put upon the importance of skimmed milk as food from which the following is quoted.

"The value of skimmed milk as food on the farm is not generally appreciated. Taken by itself, it is rather 'thin' and, as people say, 'does not stay by.'" The reason for this is simple; one has to drink a large quantity to get the needed nourishment, and further it is so readily disposed of that it does not satisfy the sense of hunger. But when eaten with bread, or used in cooking, it is a food material the value of which is not at all appreciated by the farmer. A pound of lean beef contains about .180 pounds of flesh formers, and has a fuel value of 870 calories. Two quarts and a half, or five pounds, of skimmed milk will furnish the same amount of flesh formers, and have nearly the same fuel value as a pound of round steak. Two quarts of skimmed milk have a greater nutritive value than a quart of oysters; the skimmed milk has .14 pounds of flesh formers, and a fuel value of 680 calories, while the oysters contain only .12 pounds of flesh formers, and have a fuel value of 470 calories.

A few of the ways in which skimmed milk may be used in cooking are as follows: In the preparation of soups such as potato, celery, tomato, green pea, and green corn soups; fish, lobster, clam and oyster chowders, bisques and stews, skimmed milk will equally well replace the whole milk that the directions for preparing usually call for.

Skimmed milk makes as good white soups as whole milk. Bread mixed with skimmed milk is more nutritious than that made with water. All kinds of quick biscuit, griddle cakes, etc.,

* "Dairy Products Compared with other Food Materials," Chas. D. Woods, Agriculture of Maine, 1897, pp. 216-238.

can be made with skimmed as well as with whole milk. In most kind of cake, skimmed milk will be found a perfect substitute for whole milk. If the skimmed milk is sour, so much the better for cake and quick bread making, as only half the cream of tartar called for in the recipe will be needed.

Sweet skimmed milk can be used to advantage in making rice and Indian puddings, custards, squash and pumpkin pies and the like, in the preparation of chocolate or cocoa as a drink, in the making of sherbets and other ices, and in dozens of other ways which will readily occur to housekeepers."

The statement "Bread mixed with skimmed milk is more nutritious than that made with water" was made from a knowledge of the composition of skimmed milk and without exact experimental data. The premium list of the British Dairy Farmers' Association includes prizes for bread made with skimmed milk instead of water. Two comparisons of the chemical composition of bread made with water and skimmed milk were the only analyses found. These were as follows:

COMPOSITION OF THE DRY MATTER OF WATER BREAD AND SKIMMED MILK BREAD EXHIBITED AT THE BRITISH DAIRY FARMERS' ASSOCIATION AT LONDON.

	Dry matter—Per cent.	In Dry Matter.			
		Protein—Per cent.	Fat—Per cent.	Carbohydrates—Per cent.	Ash—Per cent.
Water bread	60.64	12.05	.20	87.27	.48
Water bread	62.80	15.43	.29	82.37	1.91
Average	....	13.74	.25	84.82	1.19
Milk bread	61.36	14.98	.83	83.73	.46
Milk bread	69.56	14.72	1.15	80.97	3.16
Average	....	14.85	.99	82.35	1.81

There was nothing to show that the same flour was used in the different samples and indeed from the analyses it would seem as though the different breads must have been made from different flours. It will be noticed that the protein in the second

water bread was higher than in either of the skimmed milk breads, and, as the results of our investigations show, this could not be true if the same kind of flour was used in making the skimmed milk bread. The marked higher percentages of fat must be accounted for by the addition of shortening or by the milk being only partly skimmed.

The practice of using skimmed milk in the making of bread is said to be quite prevalent in some sections. That the custom does not become more general must be due to a lack of appreciation of the greater food value of skimmed milk bread. In the belief that its employment in bread making is to be encouraged, and for the purpose of calling attention to the readiness with which bread may be improved, the work reported below was planned and executed.

In each of the three experiments four double loaves of bread were made, two with and two without skimmed milk. The work was done by a practical bread maker, who worked from her own formulas, no conditions being imposed except that milk should be used in one case and water in the other. The materials used were portioned out by the eye alone, but were weighed before being used. As the tables indicate, the amounts of the ingredients used varied widely, but probably no more than in ordinary practice.

WEIGHT OF MATERIALS USED IN THE BREAD.

	Water Bread.			Skimmed Milk Bread.		
	Number 6115.	Number 6118.	Number 6190.	Number 6116.	Number 6119.	Number 6191.
	Grams.*	Grams.	Grams.	Grams.	Grams.	Grams.
Flour..........	782	876	1,287	752	886	1,241
Salt............	8	9	10	9	15	10
Sugar	31	24	25	26	26	25
Lard..........	14	21	15	10	23	15
Yeast	4	4	5	4	4	5

* One ounce equals 28.35 grams. One hundred grams equal 3.5 ounces.

The bread was mixed in the early evening and baked the next morning. On each occasion the milk bread rose slowly, requiring two or three hours more time than the other. The water

made a somewhat whiter and lighter loaf than the milk. All the bread showed a fairly uniform texture, and would have been accepted anywhere as a very good bread.

The loaves were cut up, dried at 50 to 70° C, ground and analyzed by the methods of the Association of Official Agricultural Chemists. The results of the analyses follow:

COMPOSITION OF FRESH BREAD.

Laboratory number.	Kind of bread.	Water—Per cent.	Protein. (N×6.25)—Per cent.	Fat—Per cent.	Carbo-hydrates—Per cent.	Ash—Per cent.	Heats of combustion, determined—Calories.	Nitrogen—Per cent.	Carbo-hydrates*—Per cent.
6115	Water bread	40.40	8.97	1.13	48.59	.91	2,683	1.43	49.41
6118	Water bread	40.07	8.81	1.05	49.12	.95	2,704	1.41	49.89
6190	Water bread	37.84	9.02	1.03	51.35	.76	....	1.44	52.16
	Average	39.44	8.93	1.07	49.69	.87	....	1.43	50.48
6116	Skimmed milk bread	39.66	9.84	.75	48.58	1.17	2,668	1.57	49.47
6119	Skimmed milk bread	38.63	9.80	1.10	48.85	1.62	2,752	1.57	49.70
6191	Skimmed milk bread	35.62	10.29	.98	52.02	1.08	....	1.64	52.96
	Average	37.97	9.98	.94	49.82	1.29	....	1.59	50.72

COMPOSITION OF WATER-FREE BREAD.

Laboratory number.	Kind of bread.	Dry matter—Per cent.	In Dry Matter.						
			Protein (N×6.25)—Per cent.	Fat—Per cent.	Carbo-hydrates—Per cent.	Ash—Per cent.	Heats of combustion, determined—Calories.	Nitrogen—Per cent.	Carbo-hydrates*—Per cent.
6115	Water bread	59.60	15.05	1.90	81.52	1.53	4,502	2.41	82.84
6118	Water bread	59.93	14.70	1.75	81.97	1.58	4,511	2.35	83.27
6190	Water bread	62.16	14.50	1.67	82.60	1.23	....	2.32	83.88
	Average	60.56	14.75	1.77	82.03	1.45	....	2.36	83.33
116	Skimmed milk bread	60.34	16.31	1.25	80.50	1.94	4,423	2.61	81.93
119	Skimmed milk bread	61.37	15.97	1.80	79.57	2.65	4,456	2.55	81.00
6191	Skimmed milk bread	64.38	15.97	1.21	81.13	1.69	....	2.55	82.56
	Average	62.03	16.08	1.42	80.40	2.09	....	2.57	81.83

* Assuming protein = N×5.7.

A comparison of the average composition of the water-free breads shows that the most important difference is in the amounts of protein which they contain, the milk bread containing about one-eleventh more protein than the water bread.

THE DIGESTIBILITY OF SKIMMED MILK BREAD.

Rehsteiner and Spirig * have made the only experiments upon the digestibility of skimmed milk bread by the natural method which have come to our notice. In two tests of three days each with a diet of skimmed milk bread, butter and tea they obtained the following results:

NUTRIENTS CONSUMED AND EXCRETED IN THE FECES.

	Dry matter—Grams.	Nitrogen—Grams.	Fat—Grams.	Carbohydrates—Grams.
No. 1:				
In food	1,779.81	39.245	333.36	1,098.42
In feces	52.66	2.33	4.73	....
No. 2:				
In food	1,533.00	34.32	267.39	960.99
In feces	58.90	3.84	8.71	....

DIGESTION COEFFICIENTS OF SKIMMED MILK BREAD AS FOUND BY REHSTEINER AND SPIRIG.

	Dry matter.	Nitrogen.	Fat.
Test 1	97	94	98
Test 2	96	92	93

These figures are lower than we have found for bread with a mixed diet, but as noted on p. 196 in this report, we have found bread when eaten alone not as completely digested as when eaten with other food.

Artificial digestion experiments with pepsin solution were used with two lots of the breads here reported upon and no practical difference in the digestibility of the protein was found. The results follow:

*Corbl. Schweizer Aerzte, 25, pp. 705-710.

DIGESTIBILITY OF THE PROTEIN OF WATER BREAD AND SKIMMED MILK BREAD IN PEPSIN SOLUTION.

Lab. No.		% digested.	
6,115	Water Bread,	95.62	
6,118	Water Bread,	93.79	
	Average,		94.70
6,116	Milk Bread,	94.32	
6,119	Milk Bread,	94.10	
	Average,		94.21

CONCLUSION.

Skimmed milk bread contains more protein (muscle forming food) than water bread.

Skimmed milk bread is as completely digested as water bread. The use of skimmed milk in bread making utilizes a valuable waste product of the dairy.

POLLINATION AND FERTILIZATION OF FLOWERS.*

W. M. MUNSON.

Several years ago the writer undertook the study of some of the problems connected with the pollination of flowers, and some of the results obtained were published in the report of this Station for 1892. Since that time the pressure of other duties has crowded the work out, but it is now thought possible to make a somewhat systematic study of the subject, and the present paper is designed to touch upon a few of the more salient points and bring together data for work during the ensuing year, rather than to treat any one subject exhaustively.

The peculiar situation of the male sexual element at some distance from the female, and the interposition of a mass of tissue through which the former must penetrate, suggest many problems relative to the coming together of these before and after actual coalescense. The first part of these notes will treat of the histological aspect of the case; the second is a summary of previous work attempted by the writer.

NOTES ON FERTILIZATION.

THE PASSAGE OF THE MALE NUCLEUS FROM POLLEN-GRAIN TO EMBRYO SAC.

On the Character of the Pollen-Grain: It is unnecessary at this time to consider the size, form and external markings of the pollen of different species. But, in general, a pollen grain contains, besides the large asexual vegetative nucleus of the cell, a smaller generative nucleus, and a certain amount of nutritive material—starch, maltose, etc.,—together with diastase and invertase necessary in rendering the latter elements available.

*The basis of this paper was presented before the Society for the Promotion of Agricultural Science at the Boston meeting, 1898.

In the Angiosperms the two nuclei are free in the general cell of the grain, but in Gymnosperms there is a different condition. In the latter as shown by Strasburger,* the pollen-grain, while still in the anther, *e. g.* in *Larix Europæa*, or after it reaches the nucleus, as in Taxus, divides into several distinct cells. The steps in this division are as follows: The undivided pollen-grain first separates into a large and a smaller biconvex cell, the latter being crowded against the side of the wall of the pollen-grain. Soon another cell is cut off from the large one, and pressed closely against the first, both being much flattened, then a third much more strongly arched cell is cut off from the large one. This third is placed over the other two, but instead of flattening out, divides later into a small stalk cell (*Stielzelle*) and a larger body cell.

As a result of the above mentioned divisions of the pollen-grains of Gymnosperms, we find then, at the time of pollination, three cells; the large cell which forms the pollen-tube, the small stalk-cell, and the body cell, which later by division gives rise to two cells containing the male nucleus.

On the Germination of Pollen and the Growth of the Pollen-Tube: The first step of the coming together of the male and the female elements is that of pollination, the conveyance of pollen from the anther to the stigma. The time intervening between this transfer, and the actual process of fertilization, may vary from a few hours in some species, to many months in others. According to Schleiden, *Cereus grandiflorus*, with a style six inches long, requires but a few hours; *Colchicum autumnale*, with a style 13 inches long, 12 hours; *Pinus Sylvestris*, almost as many months.

The fact that the pollen grain after falling upon the stigma, goes through a process of germination, in its gross characteristics comparable to that of a seed, has long been known. In 1871 this germination was carefully studied and demonstrated by Van Tieghem,† who compared the phenomenon to the germination of the spores of lycopods and many ferns, the pollen-tube corresponding to the prothallium of the latter.

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*Strasburger. Befrucht bei den Phanerogamen, 2.

† Van Tieghem: "Recherches physiologique sur la vegetation du pollen," etc. Ann. des Sci. Nat., (Bot.) 5e Ser., Vol. 12, p. 312. (1871.)

As already suggested, the pollen-grain is provided with a liberal supply of reserve food materials, which during the process of germination are changed and made available for the nutrition of the growing tube. Nor is this supply of food materials confined to the pollen-grain, for the connective tissue of the style is also rich in starch, sugar, maltose, etc. The absence of chlorophyll and the abundant supply of elaborated food materials in the connective tissue, render probable an extra-cellular digestion, depending on the active presence of certain enzymes. It has repeatedly been shown that germinating pollen grains have the power of reducing cane sugar,* while the pollen of certain species growing in weak starch paste has been found to liquify the paste and form maltose.†

J. R. Green of Kew,‡ made an elaborate investigation of the subject in 1893-4. Nearly all pollen examined by him was found to contain diastase. Among the genera named are Lilium, Helleborus, Helianthus, Gladiolus, Anemone, Antirrhinum, Tropæolum, Pelargonium, Crocus, Brownea, Alnus, Tulipa and Cliyia. Invertase was found in Helleborus, Narcissus, Richardia, Lilium and Zamia. "During the germination of the pollen, the quantity of both enzymes was found to be considerably increased; in some cases four or five fold."§

But what is the value of all this discussion concerning enzymes? As we know, the tube must make its way to the embryo sac by penetrating the intervening tissue. The enzymes appear to have the double office of dissolving the tissues in the vicinity of the tube, and of acting upon the nutritive materials as already suggested. The fact that in certain species the pollen tube goes between the cells, burrowing through the middle lamella instead of penetrating the cell walls, has led to the suggestion of a cytolytic enzyme, not yet demonstrated. Strasburger || mentions this point in connection with several genera of Caryophylaceæ and Malvaceæ. The presumption in favor

* Van Tieghem: "Inversion du Sucre de Canne par le pollen," Bul. Soc. Bot. de Frence, Vol. 33, p. 216, 1884.

† Strasburger: "Uber fraudartige Bestaubung." Jahrb. f. Wiss. Bot., Vol. 17, p. 94, (1896).

‡ Green: "On the germination of pollen and the nutrition of the pollen-tube." Phil. Trans. Roy. Soc., 1894, p. 385.

§ l. c., p. 387; also abstract, Ann. of Bot., VIII, 226, (1894).

|| Strasburger: Befrucht bei den Phan. Cited by Green, l. c.

of this enzyme is supported by the discovery of such a one, in a species of Botrytis, by Marshall Ward.*

It must not be understood, however, that the tube must always experience difficulty in passing through the connective tissue, since in some genera, especially in those of Liliaceæ, there is a distinct central passage—the pollen-canal.†

In the growing pollen-tube of the Angiosperms the large vegetative nucleus first pushes out and takes its position near the end of the tube. Later the smaller generative nucleus passes by the former, after the growth of the tube is nearly completed, and just before fertilization takes place, it divides into two. In some instances a second division of one of these nuclei has been observed, though as a rule only one of the nuclei is concerned in fertilization. In some cases, however, as shown by Strasburger to be true of *Monotropa Hypopitis*,‡ an oösphere may be fertilized by two male nuclei.

In general, the method of fertilization of Gymosperms is not essentially different from that of Angiosperms, a fact first pointed out by Belajeff§ in the case of *Taxus baccata* and later confirmed by Strasburger ‖ as the general rule. In other words, the nucleus of the pollen tube is asexual, and fertilization occurs by the union of one of the nuclei of the two cells, resulting from the division in the cell-group within the pollen-grain.

Previous to the work above cited, it had been supposed that the nucleus of the pollen-tube was the male sexual nucleus, while the cell-group in the pollen-grain was composed of asexual cells. The misunderstanding concerning the nature of the cell-group and the functions of the nuclei, arose from the erratic behavior of the same in artificial cultures. In all artificial cultures, the cells composing the group were found to retain their position in the pollen grain, thus being unable to reach the oösphere; while the nucleus of the pollen-tube being at the end of the tube, would be in the natural position to fertilize the female nucleus. Belajeff, however, in the work above cited, found that on the

* Marshall Ward: Ann. of Bot. II, 319, (1888).

† This is particularly well shown in Yucca. See Webber, Am. Nat., XXVI, 774 (1892); also Riley, Yuccas and their Pollination, III Rep. Missouri Bot. Gard., pp. 99-158.

‡ Strasburger: Befrucht und Zellth, Taf. IV, fig. 130; also referred to Bef. bei den Phan., 64.

§ Belajeff: Berichte der Deutschen bot. Gesellsh, Bd. IX, 290, (1891).

‖ Strasburger: Befrucht bei den Gymnospermen (1892).

nucellus the cells of the pollen of Gymnosperms behave differently.

The fertilization of *Pinus sylvestris*, as worked out by Dixon* in Strasburger's laboratory, may serve as an illustration. "In this species about thirteen months intervene between the time of pollination and that of fertilization."† In the ripe pollen-grains are to be seen a small prothallium cell, (the last formed of the cell group already described), and a large nucleus; the latter passes into the pollen-tube which is formed immediately after pollination. The tubes penetrate a short distance into the hard brownish tissue at the top of the nucellus, where they remain quiescent till the following spring, presenting the appearance shown in fig. 1. Late in April the pollen-tube becomes filled with starch, and the prothallium cell divides, as already noted, into a small stalk-cell; the latter soon separating into two cells of about equal size, the male sexual cells. About the same time the wall of the stalk-cell is ruptured, and its nucleus follows the two sexual cells into the pollen-tube.

The growth of the tubes through the brown tissue at the top of the nucellus is very slow, and at this time the tube often branches two or three times, as shown in the cut; eventually, however, but one branch is continued. The cells of this upper part of the nucellus are relatively poor in starch contents, but the tube is often gorged with starch and the action of the enzymes is evident in the way in which the tubes penetrate the neighboring cells, filling them with a brownish substance.

After leaving the brownish portion of the nucellus, the growth of the tube through the thin walled tissue is comparatively very rapid; the nuclei of the pollen-tube and of the stalk-cell begin to degenerate, and in about ten days—about a month from the time active growth of the tube commenced—the embryo sac was found to have been reached, while in many cases, fertilization had occurred. "When the pollen tube reaches the oösphere," says Dixon,‡ "not only do the sexual nuclei pass into the latter,

* Dixon, H. H.; "Fertilization of *Pinus sylvestris*," Ann. of Bot., VIII, 24, (1894).

† This statement is made by Dixon, and is also given by Strasburger in several of his works (See Practical Botany, p. 306, 2d Eng. Ed. by Hillhouse), but in the work here detailed it would seem that the time is nearer 12 than 13 months. The cones are said to be receptive about the end of May, and as shown by Dixon, fertilization takes place about the same season of the year.

‡ l. c., 27.

but even the two asexual nuclei also. These nuclei persist for a considerable time, and are to be found in the protoplasm of the cösphere after its nucleus has divided several times." As before stated, however, only one of the male nuclei fuses with the female.

It is possible, as has been suggested, that the provision of two sexual nuclei is a condition handed down from the time when pollen-tubes normally branched, and there was a probability of two branches reaching different oöspheres. In Cupressineæ, according to Vines,* "one pollen-tube serves for the fertilization of several female organs; consequently several male gametes are produced, the first division of the generative nucleus in the pollen-tube is followed by an aggregation of protoplasm around each of the two new nuclei, so that two primordial cells are formed. Nucleus division is repeated in the primordial cell nearest the apex of the pollen-tube, without any corresponding cell formation, so that several nuclei are to be found in the dilated apex of the pollen-tube; these, with a certain amount of protoplasm, escape as gametes, and each fertilizes the oösphere of an archegonium."

At the time of fertilization the pollen-tube is perforated by a distinct pit or perforation, first described by Hofmeister,† and later by Strasburger.‡ The same phenomenon has been shown to exist in certain of the Angiosperms, notably, *Gnetum Rumphianum* and *G. ovalifolium*.§ Just before fertilization occurs, radial striæ extend from the nucleus of the oösphere into the surrounding protoplasm; likewise from the male nucleus, this phenomenon apparently preceding the re-adjustment of the centrosomes in each case. Then, when the sexual pro-nuclei unite, the new centrosomes formed lie in a plane perpendicular to the longitudinal axis of the archegonium; the first division of the oösphere occurring in a horizontal plane.

On the Method of Entering the Nucellus.—One point of interest in connection with the passage of the male element, is the

* Vines, S. H.: Physiology of plants, 616 (1886).

† Hofmeister: Pring. Jahrb. f. Wiss. Bot., Bd. 1, p. 71.

‡ Strasburger: Bef. bei den Coniferen, pp. 11-14 (1889).

§ Karsten: Cohn's Beiträge zur Biologie der Pflanzen, Bd. VI, Heft 3, p. 367. Cited by Dixon, *op. cit.*

point at which the pollen-tube reaches the nucellus. As is well known, the normal point of entrance is the micropyle. It is an interesting fact, however, that in some genera, the tube enters through the *chalazal* region—a fact first pointed out by Treub in the case of Casuarina.*

A similar phenomenon occurs in Betula, Alnus, Corylus, and Carpinus as shown by Benson,† and in Juglans as shown by Nawaschin.‡ As yet, however, the subject has received but little attention.

SOME SECONDARY EFFECTS OF POLLINATION.

While the primary object of all pollination is the production of fertile seed, there are certain secondary effects which are of interest to the botanist, and which may often be of great practical value. Some of these secondary results have been detailed in previous reports, but the work actually done here at the Experiment Station may be summarized in this connection.

Immediate Effects of Pollen.—Even before the sexual theory regarding plant reproduction was commonly accepted, the question of the immediate effect of pollen on the form and character of the pistillate parent received attention from careful observers. Early in the 18th century it was thought that the flavor and keeping quality of apples might be changed at will by using different pollen. Bradley§ at that time stated that 'if the Codlin be impregnated with the farina of Pearmain, the fruit so impregnated would last longer than usual and be of a sharper taste.' From that time to the present there has been a sharp controversy concerning this point. The writer's work in this connection has been mainly confined to the Cucurbitaceæ and Solanaceæ, in which groups widely varying types have been crossed, but in no instance has there been observed an immediate effect.

*Treub: "Sur les Casuarinèes et leur place dans le système natural." Ann. du Jard. Bot. de Buitenzorg, x, 145-231. Cited by Benson, l. c.

† Benson, Miss M.: "Embryology of British Amentiferæ." Trans. Linn. Soc., Sec. Ser., 3 (Bot.), 413, (1894).

‡ "Ein neues Beispeil der dialazogamie." Botanisches Austr̈alblatt, Bd. 63, p. 353 (1895).

§ Bradley: "New improvements in planting and gardening," p. 18, (7th ed., 1739).

The nature of cucurbitaceous plants is well adapted to show the immediate effects of crossing, if such occur. In a mixed plantation many of the flowers on any individual plant, when left to natural processes, would necessarily receive pollen from very different sources. If, now, there were an immediate effect of pollen, we should expect to find fruits of very different character on any vine. We should expect to find the evidences of the pumpkin upon the fruits of squashes; of the melon upon cucumbers; of the different varieties of the several species upon each other. Such is not the case, however. I have repeatedly lookd for this foreign influence in the current generation, but have never seen it; nor has such influence been observed when several flowers on the same plant were artifically crossed with pollen from different varieties or species. This lack of foreign influence was particularly well shown in crossing the field pumpkin with the ornamental gourd. While, in the current generation, all fruits were similar in form and size, the seedlings were exceedingly variable. Crozier* and Bailey† have repeatedly obtained like results.

In our work with tomatoes and egg plants, extending through several years, there has, in no case, occurred an instance of the immediate effect, other than alteration of form due to insufficient pollen. The accompanying figures, used in a previous report,‡ show very clearly the entire absence of immediate effect when some of the most violent crosses are made.

Fig. 3 represents the "Lorillard," each fruit of which has been crossed by the "Currant," (*Lycopersicum esculentum* $\times$ *L. Pimpinellifolium*). The Lorillard is a smooth nearly spherical variety of medium size, usually weighing from two to four ounces. The Currant, (fig. 6,) is very different both in size and habit. As will be observed, the fruit when crossed by the Currant, is still in every respect typical of Lorillard. The offspring from this cross, however, show unmistakable evidences of the influence of the male parent, in the habit of the plants, in the character of the foliage and flowers, and in the size and character of the fruit.

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* Ag. Sci. I, 227.

† Bul. 25, Cornell Univ. Exp. Sta. 181 (Dec. 1892).

‡ Rep. Maine Exp. Sta. 1892, pp. 37, *et seq.*

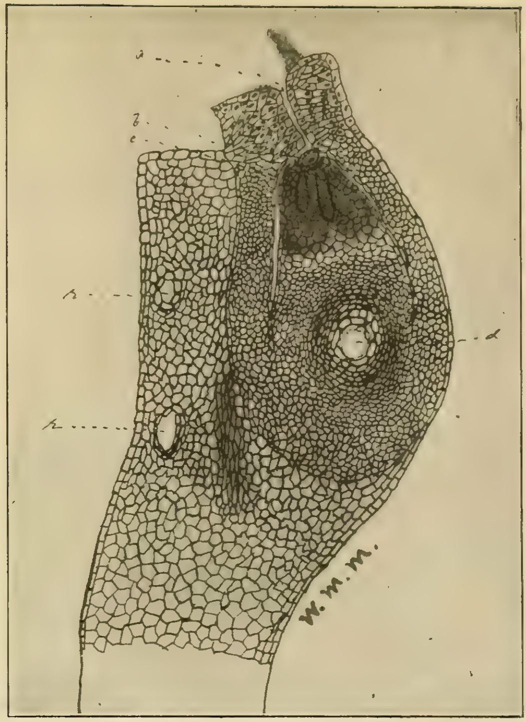

FIG. 1. OVULE OF PINUS SYLVESTRIS, SHOWING THE GROWTH OF THE POLLEN TUBES.

FIG. 2. A SEEDLESS EGG FRUIT.—NOT POLLINATED.

FIG. 3. "LORILLARD" X "CURRANT."—NO IMMEDIATE INFLUENCE OF POLLEN IS SHOWN.

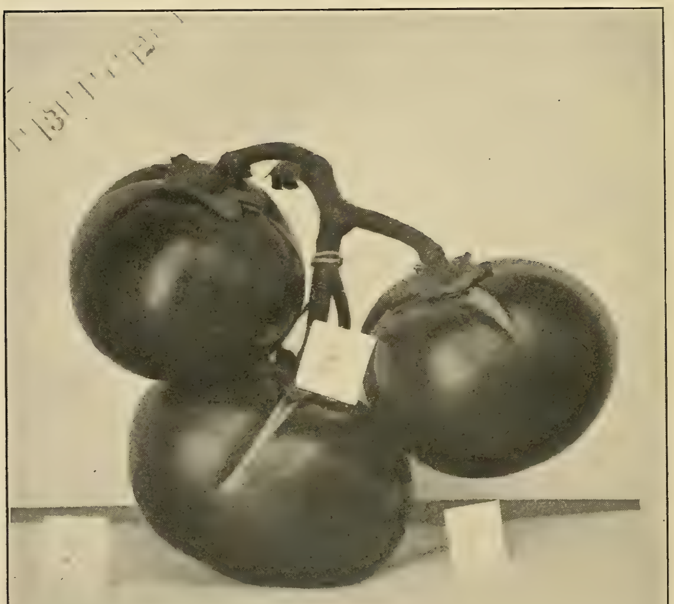

FIG 4. EACH FLOWER WAS CROSSED WITH POLLEN FROM A DIFFERENT SOURCE.

FIG. 5. SEEDLESS CUCUMBER.—NOT POLLINATED.

FIG. 6. THE CURRANT TOMATO.

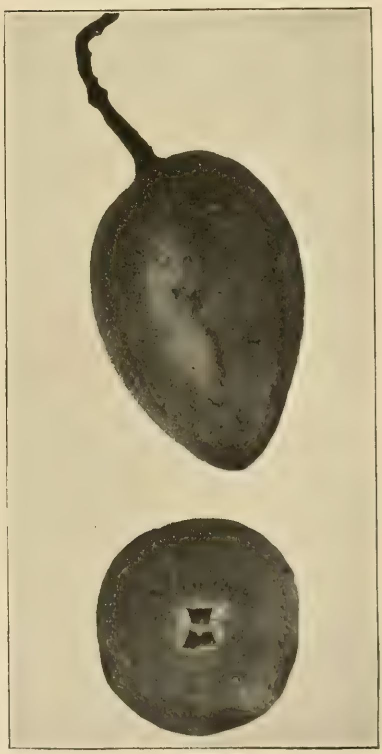

FIG. 7. THE PEPINO.

(*Solanum muricatum*, Ait.)

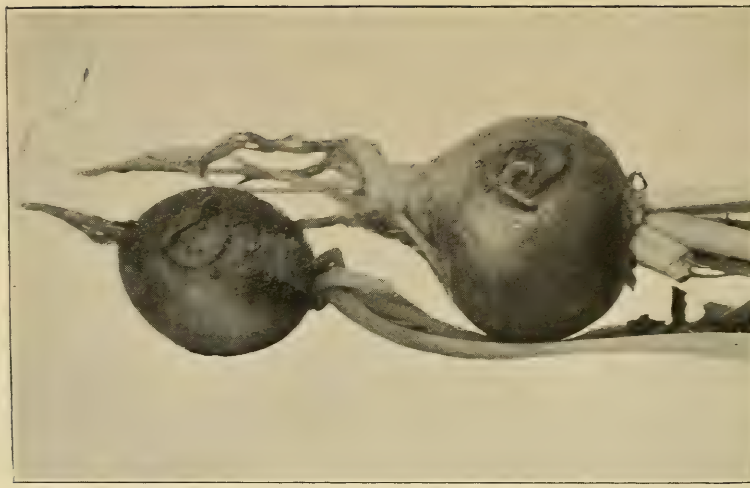

FIG. 8. RADISHES ATTACKED BY MILLIPEDES.
See pages 118 and 163.

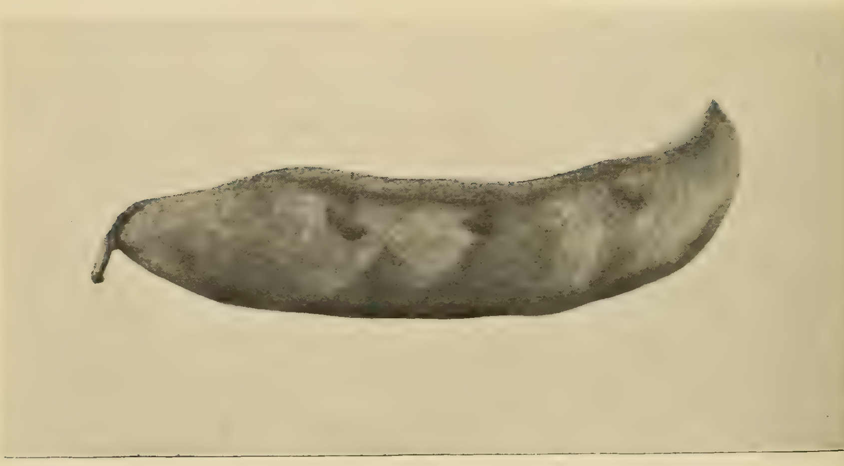

FIG. 9. SEEDLESS LIMA BEAN—NATURAL SIZE.
See page 228.

FIG. 10. SHOWING THE INFLUENCE OF AN EXCESS OF POLLEN AS COMPARED WITH A SMALL AMOUNT.

FIG. 11. CROSS SECTION OF FRUITS SHOWN IN FIGURE 10.

In another instance, figure 4, each of three flowers was crossed with pollen from a different source. "The variety used was the Lorillard. Number 1 received pollen of the same variety, number 2 was given pollen of the Currant, and number 3 from the Peach. As in the previous instance, there is no apparent effect on the form of the fruit; and the seeds gave no indication of different parentage—all were apparently typical Lorillard seeds. In the offspring, the differences are marked. The lines are sharply drawn between the crosses with Peach and Currant, the influence of the respective male parents being very evident, while the Lorillard cross is apparently unaffected by either of the others; indicating that there was no error in the operation, also that there has been no transfer of influence along the short peduncles."*

In an extended series of experiments with egg plants, conducted for three consecutive years at the Cornell University and the Maine Experiment Station, the most widely varying types have been crossed. In no instance, however, has there appeared an immediate effect of the male parent. The little Round White, when crossed with pollen from Black Pekin, differed in no respect from other fruits on the same plant. But the offspring of this cross showed very marked variations. The same facts were observed regarding several other crosses.†

Numerous instances have been reported in which the color of flowers was apparently changed by the action of foreign pollen the current season. Such an instance, however, has never come under the observation of the writer, though numerous crosses have been made with different varieties of Tropæolum, Fuchsia, Silene, Phlox, Petunia, Pelargonium, and other ornamental plants.

The statement made in the previous report upon this subject still holds: "It would be unwise at the present time, to assert that the directing influence of pollen does or does not as a rule extend beyond the fertilization of the seed. It seems not improbable that pollen from a vigorous plant may make an

* Rep. Maine Expt. Station, 1892. p. 39.

† Bailey and Munson, Experiences with egg-plants, Bul. 26, Cornell Univ. Exp. Sta., p. 14; also Rep. Maine Exp. Sta., 1892, p. 81.

imprint of its character on the female organism, which shall be different from that of a less vigorous male parent. It is probable, however, that the vigor and inherent vitality of the plant operated upon may determine whether this be manifested. Some species show apparently unmistakable evidences of the influence of foreign pollen,—this is notably true of peas and Indian corn. On the other hand, cucurbitaceous and solanaceous plants seem to resist all foreign influences; while rosaceous plants are in dispute, with the weight of authority tending to show the absence of immediate influence." This point will be the subject of special attention during the present year.

The Stimulating Influence of Pollen.—Focke says, "Pollen has two actions on the female organs, one on the seeds and one in exciting the growth of the fruit."*

It is a matter of common observation that, as a rule, when pollination fails to result in fertilization, or when pollen is withheld, not only the pistil withers, but the entire flower decays and falls. Instances are not infrequent, however, which point to a responsive action on the part of the pistil or other portions of the flower receiving pollen, while from an insufficient quantity of pollen, lack of affinity on the part of the species crossed, or some other cause which remains to be determined, fertilization does not occur. Examples of this are specially common in all of our cultivated fruits and vegetables, particularly garden beans and in the English forcing cucumber, shown in figures 9 and 5, respectively.

The pepino, *Solanum muricatum,* (fig. 7), is also a case in point. This plant blooms profusely and, under proper conditions, sets a considerable amount of fruit, which, however, is invariably seedless. The writer has made repeated attempts to cross this species with other solanums but thus far without success.

Since the work of Koelreuter in 1765,† little has been done toward determining the actual amount of pollen required for the fertilization of any given species; but in our own work the fact that the amount of pollen applied may have great practical importance in determining form and size of the fruit, as well as

* Die Pflanzen mischlinge, 447.

† Cited by Sachs, Hist. of Botany, 408.

the quantity, has been plainly and repeatedly demonstrated. This fact, which is of special importance to the horticulturist, is particularly well shown by the tomato as seen in figures 10 and 11. Upon the same cluster one flower was given a small amount of pollen—10 to 20 grains—on one side of the stigma; the other was given an excess, the stigma being well smeared. This work was repeated many times and in each case the results were the same. The fruit receiving an abundance of pollen was of normal size and nearly symmetrical in form, while the other was small and deformed. It was further found that the position of the flowers in the cluster has no influence in determining this point.

As already intimated the above notes are given for the purpose of briefly summarizing some of the more prominent features of the subject heretofore considered at this Station, rather than as a report of progress. The latter report will appear in bulletins during the ensuing year. The points for special consideration this year are: The growth of the pollen tube; a revision of the list of species supposed to show immediate effects of pollen; the stimulating action of pollen; the possibility of superfœtation.

METEOROLOGICAL OBSERVATIONS.

The observations summarized in the table on the following page were made by members of the Station force. The instruments employed are similar to those in use by the U. S. Weather Bureau, and include: Wet and dry bulb thermometers; maximum and minimum thermometers; thermograph; rain-gauge; self-recording anemometer; vane and barometer. Observations at Orono were begun in 1869 and the almost unbroken record now covers a period of thirty years.

The weather for 1898 was remarkable in but few particulars. While January and April were cooler than the average, all the other months were warmer than usual, the mean temperature for the year being one and one-half degrees above the average. April, which is here the driest month of the year as regards rain-fall, was unusually wet, while May was remarkable for its small rain-fall, less than one-third the average. The snow-fall for January and February was nearly double the usual amount. The hours of observation were 7 A. M., 2 P. M., and 9 P. M. Lat. 44°, 54′, 2″, N. Long, 68°, 40′, 11″, W. Elevation above the sea, 150 feet.

METEOROLOGICAL SUMMARY FOR 1898.

Observations made at the Maine Experiment Station.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest barometer	30.43	30.43	30.64	30.23	30.19	30.19	30.34	30.10	30.25	30.33	30.35	30.43	30.33	....
Lowest barometer	28.99	28.63	29.33	29.38	29.39	29.15	29.40	29.51	29.45	29.27	29.01	29.02	29.21	....
Mean barometer	29.88	29.89	30.01	29.74	29.80	29.77	29.85	29.79	29.83	29.92	29.81	29.77	29.84	....
Highest temperature	41	47	60	65	76	87	99	85	85	86	55	43	....	....
Lowest temperature	—30	—25	5	9	28	36	39	41	29	19	10	—14	....	....
Mean temperature	13.2	24.3	32.2	38.8	53.1	65.1	68.3	67.3	58.6	47.2	36.3	21.4	43.8	....
Mean temperature for 30 years	16.0	19.3	27.6	40.2	52.4	61.9	66.9	64.9	57.0	45.7	34.2	21.2	42.3	....
Total precipitation in inches	6.32	8.05	2.23	4.95	1.02	5.28	2.44	3.14	2.29	6.19	6.84	1.07	....	49.82
Mean precipitation for 30 years	4.28	4.12	4.17	2.94	3.43	3.59	3.31	3.79	3.38	4.05	4.53	3.78	....	45.37
No. days with precip. of .01 inch or more	9	9	7	12	4	10	5	7	5	7	8	4	....	87
Snow fall in inches	42.5	39.0	13.0	9.0	....	....	....	....	....	....	6.0	7.0	....	116.5
Average snow fall for 30 years	23.6	22.1	17.7	6.2	....	....	....	....	....	1.0	7.8	17.3	....	95.7
Number of clear days	14	8	18	13	12	9	14	12	14	9	7	11	....	141
Number of fair days	4	2	5	5	5	10	7	12	13	10	3	10	....	86
Number of cloudy days	13	18	8	12	14	11	10	7	3	12	20	10	....	138
Total movement of wind in miles	5453	6174	5653	7798	6499	5819	5560	4833	5094	6780	7476	5991	....	....

REPORT OF THE TREASURER.

Maine Agricultural Experiment Station in account with the United States appropriation, 1897-8.

DR.

To receipts from the Treasurer of the United States as per appropriation for the fiscal year ending June 30, 1898, as per act of Congress approved March 2, 1897		$15,000 00

CR.

By salaries:		
(a) Director and administration officers	$1,740 01	
(b) Scientific staff	4,998 29	
(c) Assistant to scientific staff	1,125 85	
(d) Special and temporary services	23 30	
Total		$7,887 45
Labor:		
(a) Monthly employees	$920 00	
(b) Daily employees	381 27	
Total		1,301 27
Publications:		
(a) For printing	$158 50	
(b) Printing annual report	-	
(c) For envelopes for bulletins and reports	217 37	
(d) Other expenses	3 85	
Total		380 02
Postage and stationery		430 63
Freight and express		253 70
Heat, light and water		742 60
Chemical supplies:		
(a) Chemicals	$275 85	
(b) Other supplies	314 19	
Total		590 04
Seeds, plants and sundry supplies:		
(a) Agricultural	$66 65	
(b) Horticultural	371 12	
(c) Botanical	46 15	
(e) Miscellaneous	33 67	
Total		517 59

Fertilizers		$172 32
Feeding stuffs		455 70
Library		179 53
Tools, implements, and machinery		234 27
Furniture and fixtures		295 79
Scientific apparatus		201 08
Live stock:		
(f) Sundries		250 02
Traveling expenses:		
(a) In supervision of Station work	$104 99	
(b) In attending various meetings	60 00	
Total		164 99
Contingent expenses		193 00
Building and repairs:		
(a) New buildings		750 00
Total		$15,000 00

ISAIAH K. STETSON, *Treasurer.*

I, the undersigned, duly appointed Auditor of the Corporation, do hereby certify that I have examined the books of the Maine Agricultural Experiment Station for the fiscal year ending June 30, 1898; that I have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000.00, and the corresponding disbursements, $15,000.00; for all of which proper vouchers are on file and have been examined by me and found correct.

And I further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

A. W. HARRIS, *Auditor.*

Maine Agricultural Experiment Station in account with Fertilizer Inspection for the year ending December 31, 1898.

DR.

To receipts for licenses	$2,515 00	
Balance to account of 1899	20 04	$2,535 04

CR.

By collection and analyses of samples	$1,488 80	
Executive and office expenses	700 00	
Balance carried from 1897 account	346 24	$2,535 04

Maine Agricultural Experiment Station in account with Feed Inspection for the two years ending December 31, 1898.

DR.

To receipts for inspection tags, 1897	$1,834 66	
Receipts for inspection tags, 1898	1,541 02	
Balance to account of 1899	1,014 01	$4,389 69

CR.

By collection and analyses of samples	$1,921 82	
Tags and printing	1,286 62	
Executive and office expenses	1,181 25	4,389 69

Maine Agricultural Experiment Station in account with Creamery Inspection for the year ending December 31, 1898.

DR.

To funds for calibrating glassware	$92 07

CR.

By expense calibrating glassware	$92 07

Maine Agricultural Experiment Station in account with "General Account" for the year ending June 30, 1898.

DR.

To balance from 1896-7	$1,682 73	
Sales of produce, etc	1,158 35	
	269 49	$3,110 57

CR.

By salaries	$1,470 40	
Labor	71 87	
Postage and stationery	21 85	
Freight and express	10 26	
Chemical supplies	103 52	
Seed, plants, and sundry supplies	121 42	
Tools, implements and machinery	24 44	
Furniture and fixtures	51 77	
Live stock	9 87	
Local telephones	76 47	
Buildings and repairs	350 16	
Balance to 1898-9 account	798 54	3,110 57

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